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AUTHOR	Pollock, Steve; Henegar, Wayne
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ABSTRACT

This curriculum guide uses six units to classify the areas of study which are taught under the broad category of Heavy Equipment Operation and Maintenance. The units are Safety and First Aid (1.0.0), Heavy Equipment Maintenance (2.0.0), Heavy Equipment Operation (3.0.0), Truck Driving (4.0.0), Diesel Mechanics (5.0.0), and Construction Surveying (6.0.0). The units and sections within the units are identified by a three place numbering system: the first number refers to the unit of study, the second refers to a section within the designated unit, and the third refers to the task or objective within the designated section. Since the six units separate the material into readily accessible divisions for teaching purposes, any one of the units 2.0.0 through 6.0.0 can be taught as a separate offering. Within each unit like tasks are collected into sections for instructional continuity. Each section details tasks which have been identified as essential or desirable for the development of entry level skills in the job field, with each task written as a measurable objective in a format which includes the following: Title of the competency (task), objective, equipment, special preparation (in some tasks), student action, performance check, and resources. (HD)

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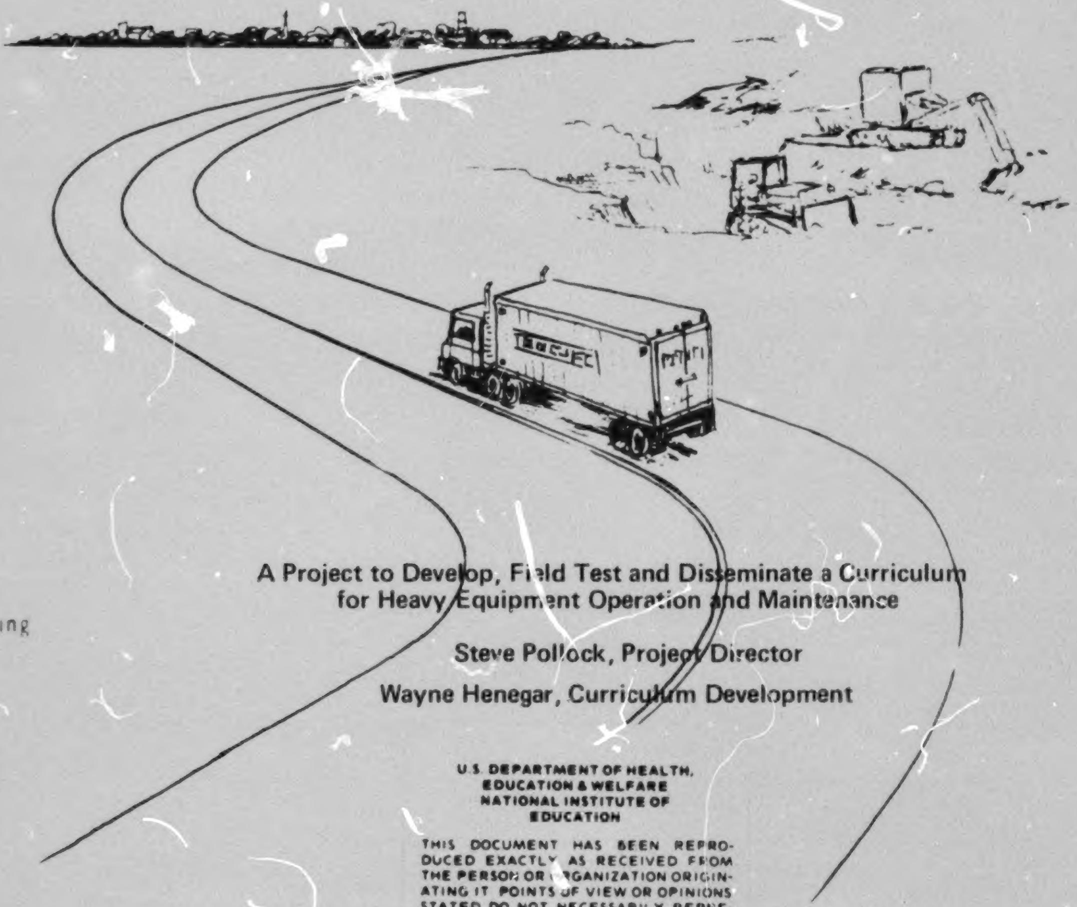
A CURRICULUM GUIDE

for

HEAVY EQUIPMENT OPERATION AND MAINTENANCE



Safety & First Aid
Operation
Maintenance
Truck Driving
Diesel Mechanics
Construction Surveying

A Project to Develop, Field Test and Disseminate a Curriculum for Heavy Equipment Operation and Maintenance

Steve Pollock, Project Director

Wayne Henegar, Curriculum Development

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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Wayne Henegar
April 1976

Foreword

The Heavy Equipment Operation and Maintenance vocational program was implemented in 1970 at Edwards County Senior High School. This was the first program of this type in Illinois for high school students. Enrollment in the program has increased each year, from 12 students the first year (1970) to 100 students this year (1975-76). Students enroll for two hours per day for two years. The program objectives are to teach salable skills at the entry level in the following areas: Heavy Equipment Maintenance, Heavy Equipment Operation, Truck Driving, Diesel Mechanics. Curriculum information and material for this type of high school program was not available. As the program expanded there became more of a need for research to be conducted to find material to develop a curriculum to meet the needs of the students and the world of work. In the 1974-75 school year the Heavy Equipment Department received a DAVTE grant to become a demonstration center and provide information to other schools on this type of high school program. One of the objectives of this grant was to develop a curriculum guide and to provide a demonstration day and work shop to disseminate the curriculum guide.

The following curriculum guide was developed at Edwards County Senior High School and each section was field tested in at least two classes and revisions made in the material before it was printed. We believe this curriculum guide may be used as a complete course of study for Heavy Equipment Operation and Maintenance, or parts of the guide may be used in other vocational programs.

Other material developed through these grants and available from the Vocational Office, Edwards County Senior High School, Albion, Illinois are:

1. Demonstration Center Brochure for Heavy Equipment Operation and Maintenance.

2. Joint Agreements Brochure - High School Vocational Education Program - Expanded and Improved.

3. Brochure for Using Federal Surplus Property for Vocational Educational Programs in Illinois.

Steve Pollock

INTRODUCTION

The curriculum guide uses 6 units to classify the areas of study which are taught under the broad category of Heavy Equipment Operation and Maintenance. The six units separate the material into readily accessible divisions for teaching purposes. Any one of the units 2.0.0 through 6.0.0 can be taught as a separate offering.

Within each unit like tasks are collected into sections for instructional continuity. In each section are detailed tasks which have been identified as essential or desirable for the development of entry level skills in the job field. In most cases these tasks are listed in order of difficulty (simple to complex) and sequence of instruction.

Each task is written in measurable objective form, as set forth in the Illinois Occupational Curriculum Project Manual (I.O.C.P). The objectives are written with three component parts: the condition, the outcome, and the criteria (see page v). The condition is a statement of a given stiuation, like "Given a straight truck and a dock, . . . " The outcome is a statement of what will result, like ". . . the student must back the truck to the dock . . .". The criteria is the specification that determines when the student has met the outcome statement, like " . . . within 6 inches of the dock measured at the center of the truck."

The identification of competencies was done by surveying men in the field of construction. They suggested entry level competencies and helped set the specifications of the criteria. Knowledge was also drawn from the experience of the instructors in the program.

FORMAT OF THE CURRICULUM

the number of the unit
the section of "x" unit
the task of "y" section

0.0.0 Title of Competency

OBJECTIVE:	A statement of the task to be learned. It includes the conditions for application of the competency, a statement of the competency (task), and the criteria which exhibits satisfactory completion of the competency.
EQUIPMENT:	A list of equipment and/or supplies necessary for the conditions (as specified above.)
SPECIAL PREPARATION:	A statement of preparation which must be completed by the teacher before the task can be taught and/or measured.
STUDENT ACTION:	A detailed statement of the competency or task which the student is to learn.
PERFORMANCE CHECK:	A method of measuring the student's performance. Written testing is used in some cases. Most Performance Checks are visual observations of performance in relation to the criteria of the objective.
RESOURCES:	A listing of printed material for teacher and/or student use. The resources are to supplement the teacher's knowledge and background, as well as provide additional study for the student.
NOTE:	A specific point of interest which needs to be called to attention. It is a warning for possible pitfalls, a "trick-of-the-trade," or a discovery from the field testing of the competency.
CAUTION:	An item of specific safety emphasis.

THE EXPLANATION OF THE NUMBERING SYSTEM

The curriculum has been given a numbering system to expedite use and a facilitate quick reference. For this purpose a three place numbering system was designed. The number holding the first place refers to the unit of study. The number holding the second place refers to a section within the designated unit. The number holding the third place refers to the task or objective within the designated section.

The first place digit. The first digit of place designates the unit as follows:

1.0.0	Safety & First Aid
2.0.0	Heavy Equipment Maintenance
3.0.0	Heavy Equipment Operations
4.0.0	Truck Driving
5.0.0	Diesel Mechanics
6.0.0	Construction Surveying

When the reader sees, for example, the number 4.1.3, he realizes that the 4 designates this as a page or a task within the Truck Driving Unit. When the reader sees the number 6.2.1, he will recognize this as a page or a task within the Construction Survey Unit.

The second place digit. The second digit designates the section within a unit. For example, unit number 6.0.0 is broken into three sections and numbered respectively, 6.1.0 measurement, 6.2.0 elevation, 6.3.0 layouts. Whenever the reader sees a number which starts as 6.1._, he realizes that the 6 defines it in the Construction Survey Unit and the 1 puts it into the first section (measurements). Likewise, a 4.1._ would be the first section of the Truck Driving Unit (the section of regulations and inspection). A 2.9._is defined as Heavy Equipment Maintenance and the ninth section (electrical).

The third place digit. The third place digit is the number of the task within the designated section of that unit. Each task within a specific section of a unit is put into a suggested order. In some cases the tasks are most easily taught in the suggested order; in other cases the tasks may be taught in a varied order.

When the reader sees a 1 in the third place, he knows this is the first task within that section. Likewise a 2 is the second task within that section, 3, 4, and so on. The number 6.1.1 would be recognized as Construction Surveying, the first section (measurements), and the first task in that section of the unit. Likewise, 6.1.2 would be the second task of the first section (measurements) of the 6th unit (Construction Surveying). In a like manner 2.9.18 is defining the 18th task of the 9th section (electrical) of the second unit (Heavy Equipment Maintenance).

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1.1.1 Safe Working Attire

OBJECTIVE: Given a working condition, the student must demonstrate his knowledge of proper working attire by wearing such to the instructor's satisfaction.

EQUIPMENT:

- hard hat
- goggles
- safety shoes

STUDENT ACTION: The student wears tight clothing to avoid getting caught in machinery. Hair should be at a safe length, or proper tied to avoid getting caught. The student should wear a hard hat. Goggles are left to the student's judgement, depending on the type of work.

PEROFRMANCE CHECK: The instructor observes the student's attire to determine if the student is properly dressed and protected. The instructor should consistantly check for the safety judgement of the student. When necessary, remind the student and enforce necessary safety regulations.

1.1.2 Safe Regard For Other Workers

OBJECTIVE:	Given a working situation, the student must consistantly show safe regard for the co-workers to the instructor's satisfaction.
STUDENT ACTION:	The student learns to watch for the safety of fellow workers When operating equipment, the student must see that others are at a safe distance.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student is operating at a safe distance from other workers. The instructor should consistantly check for the safety judgement of the student. When necessary, remind the student and enforce necessary safety regulations.

1.1.3 Safety Consciousness

OBJECTIVE: Given a working situation, the student must demonstrate safe working procedures to the instructor's satisfaction.

STUDENT ACTION: The student learns to use safe operating procedures for any job. The student learns to judge speed of travel, danger of slopping with a machine, danger of tipping, balance of load, center of gravity and stopping distance. The student learns to maintain a safe position when operating equipment with moving parts.

PERFORMANCE CHECK: The instructor observes the student's performance to determine if the student uses safe operating procedures. The instructor should consistantly check for the safety judgement of the student. When necessary, remind the student and enforce necessary safety regulations.

1.2.0 First Aid

Standard First Aid Course Multimedia System
The American Red Cross

INTRODUCTION

Multimedia is given to students in the Heavy Equipment Class of the Edwards County Senior High School because of the danger of accidents around the large machinery. The first Aid course teaches the students to perform first aid satisfactorily in case of an accident and also prevents accidents by making them aware of the dangers involved and eliminating the causes.

Multimedia must be taught by an authorized Multimedia Red Cross Instructor. Red Cross Standard First Aid Multimedia Certificates are issued for persons successfully completing this course. Many county nurses or school nurses have received the training to teach Multimedia. To find out who is authorized to teach Multimedia in your area, contact your local American Red Cross Chapter and/or First Aid Chairman.

CLASSROOM TIME

Multimedia is divided into 4 Units, each approximately 2 hours long. There are 19 film segments, 16 practice sessions, and 13 workbook lessons. The course can be taught in one working day, in four separate 2-hour sessions, or any 2-hour combination.

UNIT DESCRIPTION

The course begins with a series of 6 short films portraying the need for first aid, poses questions on the serious aspects of the accidents, and has specific prevention messages. These same films are used later in teaching individual skills.

Basic first aid skills are taught by viewing a brief film. The skills demonstrate in the film are then practiced by the trainee. The length of the demonstration films have been kept to a minimum to insure good performance in the practice sessions. After the skills have been practiced the trainees return to their seats for another brief film or work in the program med workbook which reveiw and tests them on what they have read and learned.

Workbook sessions teach further details on the material they have just learned. Topics which do not involve additional basic skills are taught completely in the workbook. (Some of these topics include First Aid for Heart Attack, Infection, Tetanus, Animal Bites, etc.)

Students are tested on the subject material learned from films, practice sessions, and workbooks.

UNIT OBJECTIVES

This course is based upon the content of the regular 14 hour Standard First Aid and Personal Safety Course. The objectives of this course are:

(1) to teach to individuals over 14 years of age the knowledge and skills that are needed for the emergency care of the injured until a physician arrives.

(2) to create an active interest in the prevention of accidents through the elimination of their causes.

UNIT OUTLINE

Unit I - Time: 2 hours

- A. Subjects
  - 1. Introduction to course
  - 2. Wounds
  - 3. Shock
  - 4. Artificial respiration
- B. Skills
  - 1. Direct pressure, elevations, and pressure points
  - 2. Application of a tourniquet
  - 3. Artificial respiration
    - a. basic procedures for mouth to mouth artificial respiration
    - b. clearing an obstruction
    - c. deflating the stomach

Unit II - Time: 1 hour 45 minutes

- A. Subjects
  - 1. Poisoning
  - 2. Burns
  - 3. Ill effects of heat and cold
  - 4. Bandaging
  - 5. Head injury, internal injury, gunshot wounds
- B. Skills (bandaging)
  - 1. Closed spiral and open spiral
  - 2. Figure 8
  - 3. Recurrent turn
  - 4. Cravat bandage
  - 5. Triangular head bandage
  - 6. Arm sling

Unit III - Time: 2 hours

- A. Subjects
  - 1. Infection, tetanus, animal bites
  - 2. Immobilization
  - 3. Heart attack, apoplexy, simple fainting, epilepsy
- B. Skills (immobilization)
  - 1. Upper arm splint
  - 2. Forearm splint
  - 3. Ankle splint
  - 4. Kneecap splint
  - 5. Immobilizing open fracture of the leg

UNIT OUTLINE (cont'd.)

Unit IV - Time 1 hour 45 minutes

A. Subjects
   1. Foreign objects in the eye, air passages, and food passages
   2. Rescue and transfer
   3. Review
   4. Final Test
B. Skills
   1. Drag by shoulders
   2. Blanket Drag
   3. Two-Man carry
   4. Carry by extremeties
   5. Improvised litter
   6. Three-Man hammock carry
   7. Litter carry

MATERIALS AND TRAINING AIDS REQUIRED

Contact local American Red Cross chapter or authorized instructor prior to obtaining supplies.

Film, 16 mm., Reels 1-4, See Textbook List.

Workbook, Unit 1-4 - one set for each trainee
See Textbook List.

Final Test - one test for each trainee. See Textbook List.

Standard First Aid and Personal Textbook, See Reference List.
Each trainee should purchase one for his own reference.
Reusable Supplies for each 10 trainees:

ITEM	QUANTITY
Army Litter or Backboard	1
Blanket	10
Padding for splints(small towels or equivalent)	12
Pole (7')	2
Splint (12" - 14")	5
Splint (36")	6
Stick (Wood Dowel 5/8" x 6" or Equivalent) optional	5
Expendable Supplies:	
Name tags	10
Pencils	10
Magazine or Newspaper	5
Gauze pad (1")	5
Gauze pad (4")	10
Roller Bandage (2")	10

Classroom Facilities

Trainee Tables or desk	10
Trainee chairs	10
Table for course materials (approximately 3′ x6′)	1
Instructor desk or lectern	1
Instructor chair	1
16 mm. sound motion picture projector and screen	1
Clipboard	1

NOTE: Classroom should be large enough for work areas, practice sessions, and viewing of film segments.

TEXTBOOKS

Workbook Set Unit 1-4, Standard First Aid Course, Multimedia System, ARC Stock No. 321155, Price per set - $2.60.

Film Reels 1-4, 16 mm., Color, Standard First Aid Course - Multimedia System, ARC Stock No. 321613, Price per set - $235.00. Single reels available only as replacement for damaged prints. (local American Red Cross Chapter may purchase this for community use.)

Final Test. ARC Stock No. 321157, 40¢ - 10 tests.

BIBLIOGRAPHY

Safety Manual for Operating and Maintenance Personnel, Construction Industry Manufacturers Association, 111 E. Wisconsin Avenue, Milwaukee, Wisconsin 53202.

Standard First Aid and Personnel Safety, The American Red Cross, Doubleday and Company, Inc., Garden City, New York.

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2.1.1 Identifying Hand Tools

OBJECTIVE: Given any of the hand tools listed below, the student must identify and demonstrate the proper use to the instructor's satisfaction.

EQUIPMENT:

- hammers
- screwdrivers
- combination wrenches
- open-end wrenches
- box-end wrenches
- punches
- sockets & rachets
- allen wrenches
- hack saw
- pipe wrench
- adjustable wrench
- files
- pliers
- torque wrench

STUDENT ACTION: The student studies the different tools listed above and learns the proper use of the tools.

PERFORMANCE CHECK: The instructor should set up a number of different situations in which the student has to select the proper tool and demonstrate its use. If necessary, review proper usage. Make suggestions for better choice of tools to meet specific jobs.

RESOURCES:

Caterpillar Service Training Slides, Set No. I.

Snap-On filmstrip, Snap-On Tool Corporation

2.1.2 Identifying Shop Tools

OBJECTIVE: Given specific shop tools, the student must identify and demonstrate the proper use to the instructor's satisfaction.

EQUIPMENT:

- parts washer
- bench grinder
- drill press
- wheel pullers
- hydraulic press

STUDENT ACTION: The student studies the different tools listed above learns the proper use of the tools.

PERFORMANCE CHECK: The instructor asks the student to perform jobs which require him to demonstrate the proper use of the shop tools. When necessary, review the proper use of the specific shop tools.

RESOURCES: Caterpillar Service Training Slides, Set No. 2

Snap-On film strip, Snap-On Tool Corporation

NOTE: Other tools may be included as specific application demands.

2.1.3 Identifying And Using Micrometers

OBJECTIVE: Given a micrometer, the student must demonstrate proper use of that micrometer, and make readings to within ± 0.001 inch.

EQUIPMENT:

- outside micrometer (various sizes)
- inside micrometer
- dial indicator
- telescoping gauges

STUDENT ACTION: The student learns the proper use of the micrometer. He learns to tighten the micrometer to the proper tension when making a reading. The student learns to "feel" the point of maximum reading when measuring a round object. Dial indicators must be firmly mounted for accurate readings.

PERFORMANCE CHECK: The instructor observes the student's performance to determine if the student correctly learned the skill. Check is made for proper tension when reading micrometers. Secure attachment of dial indicators is checked. The instructor makes measurements and compares to the student's results.

2.1.4 Using Torque Measuring Devices

OBJECTIVE:	Given a torque wrench, the student must demonstrate proper use of the torque wrench and tighten a fastener to within ± 10% of the specified torque.
EQUIPMENT:	- torque wrench - lb. in. - torque wrench - lb. ft.
STUDENT ACTION:	The student learns the meaning of torque and ways of measuring torque. The proper use of the torque wrench is learned.
PERFORMANCE CHECK:	The instructor tests the student's understanding of torque. Check is made for proper use of the torque wrench. The instructor determines if the student tightens the fastener within the specifications. Where necessary, offer suggestions and allow time for student to practice.
NOTE:	It is suggested that the instructor give due time to discussion of torque measured in Newton-Metre graduations.

2.1.5 Using Air Impact Wrenches

OBJECTIVE: Given air impact tools, the student must correctly identify the tools and demonstrate their proper use to the instructor's satisfaction.

EQUIPMENT:

- air impact wrench (s)
- impact sockets

STUDENT ACTION: The student learns to identify impact wrenches by size (3/8", 1/2",3/4", etc.). The student also learns to identify impact sockets. Correct use of impact tools is taught. The student learns to approximate the torque being generated by the impact wrench. It is suggested that the student measure the tightness with a torque wrench. The student must learn not to overtighten bolts.

PERFORMANCE CHECK: The instructor tests the identification of air tools. Determination should be made by observation of the proper technique for air wrenches. Check for overtightening. Where necessary, offer suggestions and make provisions for practice.

CAUTION: Use only impact sockets on air impact wrenches.

2.2.0 Fasteners and Torque Specifications

Identifying bolts and nuts 2.2.1

Tightening bolts and nuts (with torque wrench) 2.2.2

Torque specifications 2.2.3

Tightening bolts and nuts (without torque wrench) 2.2.4

2.2.1 Identifying Bolts and Nuts

OBJECTIVE:	Given a bolt, the student must identify the bolt by size, grade and type of thread with 80% accuracy.
EQUIPMENT:	- an assortment of bolts from 1/4" - 5/8" - S.A.E. & U.S.S. threads
SPECIAL PREPARATION:	Provide a variety of bolts for testing.
STUDENT ACTION:	The student identifies any bolt according to the specifications. Students will learn sizes for purposes of replacement, tightening, purchasing, and application.
PERFORMANCE CHECK:	The instructor tests the student's knowledge with a random sample of bolts. The student should be able to identify 80% of the sample to meet the specifications. If necessary, review the sizes with a measuring device. Have the student sort an assortment and match sizes: then re-test.
NOTE:	The instructor should acknowledge metric measurement of nuts and bolts.

2.2.2 Tightening Bolts and Nuts (With Torque Wrench)

OBJECTIVE:	Given a specific bolt and a torque wrench, the student must tighten the bolt to the proper torque ± 5% of specification.
EQUIPMENT:	- torque wrench - a variety of bolts to be tightened.
SPECIAL PREPARATION:	Provide a group of bolts to be tightened.
STUDENT ACTION:	The students tightens the bolt to the recommended torque specifications. Emphasis is placed on smaller bolts and lower torque specifications. Student should learn to not over-tighten small bolts.
PERFORMANCE CHECK:	The instructor tests the student's performance by providing a series of bolts for the student to tighten to the proper torque. When necessary, review torquing procedures and provide another exercise for practice.

2.2.3 Torque Specifications

OBJECTIVE:	Given a specific bolt size of grade 5, the student must know the torque ± 5% of the specification.
EQUIPMENT:	- a torque specification chart
STUDENT ACTION:	The student learns the torque specifications of grade 5 bolts from 1/4" - 5/8". Knowing the torque specifications should give the student "a feel" for tightening bolts without a torque wrench. This task, when coupled with 2.2.4, should teach proper tightening on general application bolts where specific torque is not required.
PERFORMANCE CHECK:	The instructor gives a written or oral test to each student on the torque specifications of specific bolts. It is suggested that the bolt be used and identified by the student for the torque specification test. Then a student can see a bolt in its application and know how tight to tighten it.

2.2.4 Tightening Bolts and Nuts (Without Torque Wrench)

OBJECTIVE:	Given a bolt in its application, the student must tighten the bolt within ± 15 of the torque specifications without a torque wrench.
EQUIPMENT:	- a bolt in its application - necessary wrench
STUDENT ACTION:	The student learns to tighten various sizes of bolts within ± 15% of their specifications without a torque wrench. He must learn to consider the size of bolt, size of wrench, amount of leverage, etc. After tightening the bolt, the student checks his work with a torque wrench.
PERFORMANCE CHECK:	A series of bolts in their application are tightened by the student. The instructor then checks the work with a torque wrench for accuracy within the ± 15%.

2.3.0 Record Keeping Systems

Daily maintenance records 2.3.1

Maintenance jobs 2.3.2

2.3.1 Daily Maintenance Records

OBJECTIVE:	Given the necessary forms, the student must keep daily records of fuel, oil, and other minor operation costs for a specific machine.
EQUIPMENT:	- necessary forms
STUDENT ACTION:	The student learns to record the daily routine maintenance cost of a machine. Usual items are fuel, oil, lubrication, and the time involved in the routine maintenance.
PERFORMANCE CHECK:	The instructor checks the student's records to determine if he correctly records the maintenance items.

2.3.2 Maintenance Jobs and Downtime

OBJECTIVE:	Given the necessary forms, the student must record maintenance jobs performed and record the down-time.
EQUIPMENT:	- necessary forms
STUDENT ACTION:	The student learns to fill out work orders for needed maintenance and mechanical work on a piece of equipment. A description of the work is recorded on the record for that specific machine. Also the cost and downtime are recorded.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly records the maintenance and mechanical work performed.

2.4.0 Fuel Handling And System Servicing

Knowledge of fuel types and characteristics 2.4.1

Handling fuel 2.4.2

Servicing fuel systems filters 2.4.3

Bleeding fuel system 2.4.4

2.4.1 Knowledge Of Fuel Types and Characteristics

OBJECTIVE: Given the necessary information, the student must know the types of fuels (gasoline and diesel) and describe their characteristics and uses.

EQUIPMENT:

- samples of fuels

STUDENT ACTION: The student learns the types of gasoline (regular, unleaded, ethyl, and white) and diesel (No. 1, No. 2, and kerosine). The student must know the characteristics that distinguish one from the other. Also suggested application of each should be known.

PERFORMANCE CHECK: The instructor tests the student's knowledge of fuel types and their characteristics.

2.4.2 Fuel Handling

OBJECTIVE:	Given fuel handling containers, the student must demonstrate his ability to transfer fuel from storage to equipment keeping in mind such factors as safety and cleanliness.
EQUIPMENT:	- container(s) - fuel - equipment which needs to be filled with fuel
STUDENT ACTION:	The student transfers fuel from storage to equipment. Proper techniques of safety and cleanliness are emphasized.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student property executes the task.
RESOURCES:	Toboldt, Chapter I9.

2.4.3 Servicing Fuel Systems Filters

OBJECTIVE:	Given the necessary filter elements, the student must service the filter and sediment bowl to the manufacturer's specifications.
EQUIPMENT:	- engine - new filter element
STUDENT ACTION:	The student services the fuel filtering system on an engine. Emphasis is placed on cleanliness, efficiency, and checking for leaks.
PERFORMANCE CHECK:	The instructor observes the student to determine if the student performs according to the specifications. Where necessary, determine area(s) of weakness and have student perform task accordingly.
RESOURCES:	Toboldt, Chapter 15.

2.4.4 Bleeding Fuel System (Also 5.I.7)

OBJECTIVE:	Given a diesel engine with a high pressure injection pump, the student must bleed the air from the system according to the manufacturer's specifications.
EQUIPMENT:	- an engine with high pressure fuel injection system - set of tools
SPECIAL PREPARATION:	Provide a diesel engine with air in the fuel lines.
STUDENT ACTION:	The student bleeds the air from the fuel injection system. Sequential progression is followed from filter(s) and/or sediment bowl to pump to injectors.
PERFORMANCE CHECK:	The instructor observes the student to determine if air has been eliminated from the system. A smooth running engine is the best indication. Where necessary, determine area of weakness and have student perform task again.
RESOURCES:	Toboldt, Page 290.

2.5.0 Lubrication Systems and Lubricant Handling

Knowledge of lubricants and characteristics 2.5.1

Recognizing foreign matter in oil 2.5.2

Handling of lubricants 2.5.3

Changing oil 2.5.4

Changing lubrication system filter 2.5.5

Loading grease gun 2.5.6

2.5.1 Knowledge of Lubricants and Characteristics

OBJECTIVE:	Given the necessary information, the student must know the common types of lubricants and describe their characteristics and uses.
EQUIPMENT:	- samples of lubricants oil - SAE 10, SAE 20, SAE 30, SAE 10W-40, SAE 80, SAE 90, Automatic transmission fluid, Hydraulic oil grease - lithium, wheel-bearing
STUDENT ACTION:	The student learns types of oils and greases and their distinctive characteristics. The student should be able to distinguish by sight and feeling between engine oil, gear grease, transmission fluid, and hydraulic oil. The student should know suggested applications of each.
PERFORMANCE CHECK:	The instructor tests the student's knowledge of lubricants and their characteristics. Check is made for identification and examples of application.

2.5.2 Recognizing Foreign Matter In Oil

OBJECTIVE:	Given several samples of oil with foreign matter, the student must recognize that the oil is contaminated and suggest possible contaminants to the instructor's satisfaction.
EQUIPMENT:	- clean sample of oil - oil with water - oil with water & anti-freeze - oil with steel filings - oil with diesel fuel
SPECIAL PREPARATION:	Prepare the samples.
STUDENT ACTION:	The student distinguishes between clean and contaminated oil. The purpose is to recognize contaminants which could indicate and/or cause a malfunction in the engine.
PERFORMANCE CHECK:	The instructor observes the student to determine if the student properly determines the contaminant. Where necessary, reveiw samples. Let student contaminate a small sample to see the change effected by a contaminant.

2.5.3 Handling of Lubricants

OBJECTIVE:	Given a lubricant and a container, the student must know the way to store properly the lubricant and must display proper handling techniques when transferring lubricants from storage to dispensing containers.
EQUIPMENT:	- lubricants - dispensing containers
STUDENT ACTION:	The student learns the proper storage methods which protect the lubricants from dirt and moisture. The student learns to transfer lubricants from storage to the point of application without introducing foreign material.
PERFORMANCE CHECK:	The instructor tests the student's knowledge of storage methods, observes the student's performance of lubricant handling, and makes corrective suggestions as necessary.

2.5.4 Changing Oil

OBJECTIVE: Given an engine and sufficient oil, the student must change the oil to the manufacturer's specifications.

EQUIPMENT:
- engine
- oil of the proper specification and quantity

STUDENT ACTION: The student changes the oil in an engine to meet the manufacturer's specifications. Emphasis is given to cleanliness, to proper handling, to use of containers, and to checking for leaks.

PERFORMANCE CHECK: The instructor evaluates the student's performance on the basis of the objective. When necessary, the areas of weakness are given special emphasis and this task is performed again.

RESOURCES: Service Manuals for specific equipment
Toboldt . . . . Chapter 16

2.5.5 Changing Lubricant System Filter

OBJECTIVE:	Given an oil system filter, the student must change the filter and check for leaks to the instructor's satisfaction.
EQUIPMENT:	- engine - oil filter
STUDENT ACTION:	The student removes the old filter element and cleans the base (canister-type) or container (element-type). The student installs the new filter and checks for leaks. The engine should be operated for a few minutes to insure that there is no leakage.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly installs the filter.
RESOURCES:	The engine manufacturer's service manual.

2.5.6 Loading Grease Gun

OBJECTIVE:	Given a cartridge-type grease gun and grease cartridge, the student must load the grease gun to the instructor's satisfaction.
EQUIPMENT:	- grease gun - grease cartridge
STUDENT ACTION:	The student learns to clean and open the grease gun. The old cartridge is removed and a new one installed. The grease gun is reassembled and the air forced out of the gun.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly loads the grease gun.

2.6.0 Air Intake Systems and Filters

Knowledge of system and indicators 2.6.1

Servicing pre-cleaners 2.6.2

Servicing dry-type air cleaners 2.6.3

Servicing oil-bath air cleaners 2.6.4

2.6.1 Knowledge of System and Indicators

OBJECTIVE:	Given an air intake system, the student must be able to identify the component parts and know their proper function.
EQUIPMENT:	- various types of air intake systems.
STUDENT ACTION:	The student learns to identify the types of air cleaning systems by sight (dry-type or oil-bath). The student must know the path of air flow through the air intake system. He should understand the function and be able to read an indicator for the filter element. The operation and purpose of a precleaner should be known.
PERFORMANCE CHECK:	The instructor tests the student's knowledge of air systems for identification of types and function of component parts.
RESOURCES:	Operator's Manual

2.6.2 Servicing Pre-Cleaners

OBJECTIVE:	Given a pre-cleaner, the student must service the pre-cleaner to the instructor's satisfaction.
EQUIPMENT:	- a pre-cleaner
STUDENT ACTION:	The student learns the function of a pre-cleaner and the proper procedures for servicing.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly services the pre-cleaner.
RESOURCES:	Operator's Manual

2.6.3 Servicing Dry-Type Air Cleaners

OBJECTIVE: Given an engine with a dry-type air cleaner, the student must service the air cleaner by cleaning out the dirt and inspecting the element for holes, to determine the necessity of replacement with a new element.

EQUIPMENT:
- engine with dry-type filter
- new filter

STUDENT ACTION: The student changes the air filter to meet manufacturer's specifications. Inspection is made for holes in the filter element. Student judgment is exercised concerning replacement.

PERFORMANCE CHECK: The instructor observes the student's performance to determine if the student performed according to the objective.

RESOURCES: Toboldt . . . . . Chapter 15

2.7.0 Cooling Systems

Knowledge of systems and functions 2.7.1

Testing for winterized condition 2.7.2

Replacing hoses 2.7.3

Replacing thermostat 2.7.4

Replacing water pump 2.7.5

2.7.1 Knowledge of Cooling Systems and Functions

OBJECTIVE:	Given the necessary information, the student must know the component parts of an engine water cooling system and the function of each component part to 80% accuracy.
EQUIPMENT:	- the various parts of a cooling system
STUDENT ACTION:	The student learns to identify the component parts by sight. He learns the function of each and the flow of coolant through the system. He learns the indicators of malfunctions in any specific part.
PERFORMANCE CHECK:	The instructor tests the student's knowledge of cooling system. Check is made for identification, function, and indicators of malfunction.

2.7.2 Testing For Winterized Condition

OBJECTIVE:	Given antifreeze, an antifreeze tester, and proper specifications, the student must winterize a cooling system to the specifications demanded by the climate.
EQUIPMENT:	- cooling system - antifreeze - antifreeze tester
STUDENT ACTION:	The student drains the system sufficiently to allow for the necessary quantity of antifreeze to winterize the system. He adds antifreeze to winterize the system.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student has met the specifications. If the student has not met the specifications, determine if error was in calculation. If so, review and have the student figure the quantity for another system. If installation is faulty, have student correct his mistakes.
RESOURCES:	Specifications of anti-freeze manufacturer
NOTE:	Check the coolant level after the thermostat opens.

2.7.3 Replacing Hoses

OBJECTIVE:	Given a cooling system, the student must determine if there is need for replacement of hoses and makes necessary replacement according to manufacturer's specifications.
EQUIPMENT:	- an engine cooling system - necessary hoses
SPECIAL PREPARATION:	Provide an engine with a cooling system
STUDENT ACTION:	The student determines by inspection if the cooling system needs any hoses replaced. If so, he replaces the hoses to meet the manufacturer's specifications.
PERFORMANCE CHECK:	The instructor observes the student to determine if the student made the best decision on replacing (or not replacing) the hose. Inspect the hoses replaced for proper installation (tighteness of clamps, routing of hoses, and leaks). Determine if there are areas of weakness. Where possible, have the student correct his own work.

2.7.4 Replacing Thermostat

OBJECTIVE:	Given a malfunctioning thermostat, the student must diagnose the malfunction and replace the thermostat to the manufacturer's specifications of flat rate plus 20%.
EQUIPMENT:	- cooling system - thermostat replacement
SPECIAL PREPARATION:	Installing a faulty thermostat to show the characteristics of a closed thermostat.
STUDENT ACTION:	The student diagnoses the malfunction and replaces faulty thermostat with a new one.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student checked for leaks and properly installed the thermostat. Compare the student's time to that of flat rate. Any errors in installation should be corrected by the student. If time is excessive, the job should be performed again to meet the specifications.
RESOURCES:	Manufacturer's specifications

2.7.5 Replacing Water Pump

OBJECTIVE:	Given a malfunctioning water pump, the student must remove and replace the water pump according to the manufacturer's specifications.
EQUIPMENT:	- waterpump - engine with water pump to be replaced - gasket sealer
STUDENT ACTION:	The necessary parts and accessories are removed. The student removes the malfunctioning water pump. The replacement water pump is installed with new gaskets. Accessories are replaced. System is checked for leaks.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student has correctly installed the water pump to the specifications. Student should be required to correct any mistakes. Then remedial task should be done with close supervision at point(s) of weakness.
NOTE:	Care is exercised to make sure the radiator is full after the thermostat has opened.

2.8.0 Minor Tune-Up

Replacing points and condenser 2.8.1

Timing Ignition system 2.8.2

Replacing spark plugs 2.8.3

Adjusting valves (mechanical) 2.8.4

2.8.1 Replacing Points and Condenser

OBJECTIVE: Given a gasoline engine and the necessary parts, the student must determine if new points and condenser are needed and replace the points and condenser to the manufacturer's specifications.

EQUIPMENT:

- gasoline engine
- points and condenser
- dwell meter (optional-task should be performed with feeler as well)

SPECIAL PREPARATION: Provide an engine to be tuned up.

STUDENT ACTION: The student determines whether new points and condenser are needed. New parts are installed if necessary. Adjustment of point gap (or dwell) is made.

PERFORMANCE CHECK: The instructor observes the student's performance to determine if the student adjusted the points to the specifications. Determine if replacement was needed and executed. Where necessary, isolate area of error. Develop remediation around area of need.

RESOURCES: Manufacturer's specifications

2.8.2 Timing Ignition System

OBJECTIVE:	Given a gasoline engine and the necessary tools, the student must adjust the timing to one degree of the manufacturer's specifications.
EQUIPMENT:	- timing light - engine (gasoline)
STUDENT ACTION:	The student sets the ignition timing to meet the manufacturer's specifications. Check should be made for proper function of mechanical and vacuum advance.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly times the ignition system. Where necessary, isolate area of error. Review the area of weakness and assign a similar task for development of the competency.
RESOURCES:	Manufacturer's specifications.
NOTE:	Point gap (dwell) should always be set before timing the engine.

2.8.3 Replacing Spark Plugs

OBJECTIVE:	Given a gasoline engine and the necessary equipment, the student must inspect and replace the spark plugs where necessary.
EQUIPMENT:	- gasoline engine - set of spark plugs
SPECIAL PREPARATION:	Provide an engine for tune-up.
STUDENT ACTION:	The student removes the spark plugs, taking care to keep the wires in proper order. The plugs are inspected and evaluated. The student learns to evaluate the engine's condition by the condition of the plugs. New plugs are installed. Care is exercised not to crack the porcelain during handling or tightening.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student's diagnosis of plug condition is correct. Determine if installation is according to specifications.

2.8.4 Adjusting Valves

OBJECTIVE: Given an engine, the necessary tools and the manufacturer's specifications, the student must adjust the valve lash on an engine to the manufacturer's specification.

EQUIPMENT:

- engine with mechanical lifters

STUDENT ACTION: The student adjusts the valves on a engine equipped with mechanical lifters. The student draws from knowledge of firing order, valve timing, and valve lash. The student should rotate the crankshaft to the proper position for each valve adjustment.

PERFORMANCE CHECK: The instructor observes the student to determine if the student has correctly adjusted the valve lash. The instructor should check the adjustments.

RESOURCES:

Engine manufacturer's service manual
Engines, John Deere, page 2-23

2.9.0 Electrical Systems

Identification of batteries 2.9.1
Battery storage and handling 2.9.2
Filling a dry-charge battery 2.9.3
Testing battery - hydrometer 2.9.4
Testing battery - load test 2.9.5
Charging a battery 2.9.6
Connecting booster cables 2.9.7
Installing batteries 2.9.8
Cleaning battery connections 2.9.9
Orienting to test equipment - cranking system 2.9.10
Testing cranking system 2.9.11
Removing and replacing starter 2.9.12
Disassembling and testing starter 2.9.13
Diagnosing faulty solenoid 2.9.14
Removing and replacing solenoid 2.9.15
Diagnosing faulty bendix 2.9.16
Orienting to test equipment - charging system 2.9.17
Testing charging system 2.9.18
Removing and replacing generator 2.9.19
Disassembling and testing alternator 2.9.20
Disassembling and testing generator 2.9.21
Adjusting regulator (where applicable) 2.9.22
Removing and replacing regulators 2.9.23
Replacing light bulbs 2.9.24
Diagnosing turn signal malfunction 2.9.25
Diagnosing brake light malfunction 2.9.26

2.9.1 Identification of Batteries

OBJECTIVE:	Given a battery, the student must identify, the battery by voltage and amper-hour to the instructor's satisfaction.
EQUIPMENT:	· a variety of batteries
SPECIAL PREPARATION:	Provide batteries for the students to identify according to voltage amper-hour.
STUDENT ACTION:	The student identifies several different batteries to demonstrate his ability to correctly identify batteries for installation and replacement purposes.
PERFORMANCE CHECK:	The instructor tests the student's knowledge to determine if the student can properly identify batteries. If there is a weakness, assign remedial work to increase the student's competency.

2.9.2 Battery Storage and Handling

OBJECTIVE:	Given a battery temporarily out of use, the students must demonstrate proper storage of the battery to the instructor's satisfaction.
EQUIPMENT:	- a battery - blocks of wood
STUDENT ACTION:	The student properly stores the battery off concrete, and in a warm (above 32 degrees) dry place.
PERFORMANCE CHECK:	The instructor observes the student's performance and determines if the batteries are stored according to the specifications. If not, re-assign the task and provide the necessary help to give the student the needed remediation.

2.9.3 Filling A Dry-Charge Battery

OBJECTIVE:	Given a new dry-charge battery and sufficient electrolyte, the student must fill the battery and charge it according to the manufacturer's specifications.
EQUIPMENT:	- new battery - electrolyte - battery charger
STUDENT: ACTION:	The student fills the new battery to the proper level with electrolyte. Care is given to the proper handling of the electrolyte and not overfilling.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the electrolyte level is correct and if the charge rate and time was correctly determined. When necessary discuss the area of error or weakness with the student. Show the student the correct procedure. Reassign the task.

2.9.4 Tests Battery - Hydrometer

OBJECTIVE: Given a battery and hydrometer, the student must test the specific gravity of the electrolyte and evaluate the charge of the battery to the instructor's satisfaction.

EQUIPMENT:

- battery
- hydrometer

STUDENT ACTION: The student tests the specific gravity of the electrolyte, using care not to spill acid on machine or himself. From the readings of each cell he evaluates the condition of the battery. If cells are uniform in reading, he charges the battery (2.9.6). If one cell is low in reading, it is probably shorted. A quick charge should confirm the evaluation.

PERFORMANCE CHECK: The instructor observes the work of the student to determine if the student correctly evaluates the condition of the battery. Where observations show weakness in procedure, give corrective suggestions. Review the facts that lead to conclusions about the condition of the battery. Re-assign the task.

2.9.5 Testing Battery (Load Test)

OBJECTIVE:	Given a carbon pile load tester, the student must place a load on the battery to test the condition of the battery according to the test equipment specifications.
EQUIPMENT:	- carbon-pile load tester - battery
STUDENT ACTION:	Using the specifications of the test equipment manufacturer the student places a load on the battery for a specified length of time. If the battery maintains a specified voltage, the battery is in good condition. The student evaluates the condition of the battery from the data collected.
PERFORMANCE CHECK:	The instructor observes the student to determine the quality of work being done. Test the battery to check the correctness of the student's readings. Determine if the student made the correct evaluation from the data received. Note the weaknesses in the test procedure and make necessary suggestions. Assign further tasks accordingly.

2.9.6 Charging A Battery

OBJECTIVE:	Given a hydrometer and battery charger, the student must charge the battery according to the manufacturer's specifications.
EQUIPMENT:	- hydrometer - battery charger - battery
STUDENT ACTION:	The student tests the specific gravity of the battery and determines the need for charging. If needed, the battery is charged at a rate suitable to the manufacturer's specifications. The student checks the specific gravity periodically to determine the charge of the battery.
PERFORMANCE CHECK:	The instructor observes the student's performance to evaluation. Compare his use of the data and resulting conclusion with the instructor's conclusion. If charging was required, determine the correctness of the charging procedure. Make recommendations for improvement and accuracy. Determine evaluation from data. Re-assign the task.

2.9.7 Connecting Booster Cables

OBJECTIVE: Given a complete elcetrical system and an extra battery, the student connects a booster battery to the charging system to the instructor's satisfaction.

EQUIPMENT:

- a charging system
- a booster battery
- a set of jumper cables

STUDENT ACTION: The student learns to properly connect a booster battery to a charging system. Care is given to using batteries of the same voltage, and to insure that hook-ups are made in parallel (positive to positive and negative to negative).

PERFORMANCE CHECK: The instructor observes the student to make certain of proper hook-up. Different combinations should be used to provide a variety of hook-ups; i.e. 12 volt negative ground, 12 volt positive ground, 24 volt with 2-12 volts, 24 volt with 4-6 volts. Where necessary, review the type of system to be "boosted". Emphasis the parallel hook-up of booster cables.

2.9.8 Installing Batteries

OBJECTIVE:	Given a unit which needs batteries installed or replaced, the student must install the battery(s) and make proper connection according to manufacturer's specifications.
EQUIPMENT:	- unit which needs batteries - replacement batteries
STUDENT ACTION:	The student installs the battery(s) in a unit. Student should be able to determine if a unit is positive or negative ground and install battery(s) accordingly. Also care is given to proper series hook-up of more than one battery. Ground cables are always connected last after all other connections are tightened.
PERFORMANCE CHECK:	The instructor observes the student's work and evaluates the performance. Check is made for tight connections, good battery cables, tight holddowns, etc. If there is error, determine the cause. If error is understanding of electrical hook up, review lecture on series and parallel circuits.

2.9.9 Cleaning Battery Connections

OBJECTIVE:	Given a battery installation, the student cleans the posts and connectors and provides protection from corrosion with petroleum jelly to the instructor's satisfaction.
EQUIPMENT:	- a battery installation - battery post cleaner - petroleum jelly
STUDENT ACTION:	The student disconnects the battery cables and cleans the cable terminals and battery posts. Some substance such as petroleum jelly is used to retard corrosion. The student is taught to disconnect the ground cable first and reconnect it last. This prevents any shorting if the wrench touches the insulated terminal and vehicle simultaneously.
PERFORMANCE CHECK:	The instructor observes the student's action and determines if the student correctly performs the task. From observations, determine the errors which are made. Explain the error to the student. Show correct procedure. Re-assign the task.

2.9.10 Orienting to Test Equipment - Cranking System

OBJECTIVE:	Given the necessary test equipment and orientation the student must correctly connect the test equipment for testing the cranking system according to the specifications of manufacturer.
EQUIPMENT:	- Marquette model 42-148 tester (or the equivalent) - a cranking system
STUDENT ACTION:	The student correctly connects the tester for testing the cranking circuit. The student learns the proper connections, the proper use of the controls and how to read the meters.
PERFORMANCE CHECK:	The instructor observes the student's procedure when hooking up tester. Determine the correctness of the connections. Where necessary, show the student his errors. Explain correct procedure. Assign remedial tasks of hooking up test equipment until student performs tasks accurately and effeciently.

2.9.11 Testing Cranking System

OBJECTIVE:	Given the test equipment of 2.9.10 the student must test the cranking system and evaluate its condition according to the test equipment manufacturer's specifications to 80% accuracy.
EQUIPMENT:	- Marquette model 42-148 tester (or its equivalent) - a cranking system
STUDENT ACTION:	The student connects the test equipment and makes the necessary tests to check the amperage draw of the starter. He evaluates the condition of the starter, and makes recommendation of the service procedure needed, if any.
PERFORMANCE CHECK:	The instructor checks the charging system to determine the correctness of the student's procedure and readings. Determine if the evaluation of the student is in accord with the data received from the tests. If there is error, determine if it is in the testing or the evaluation of data. Explain errors to the student. Provide corrective suggestions. Reassing the task.

2.9.12 Removing and Replacing Starter

OBJECTIVE: Given a unit with an electric starter, the student must remove and replace the starter within the manufacturer's recommendations of flat rate plus 20%.

EQUIPMENT:

- a unit with electric starter

STUDENT ACTION: The student removes and replaces the starter. Care is given to correct procedure of disconnecting and connecting batteries. Also proper hookup of cables to the starter terminals is taught.

PERFORMANCE CHECK: The instructor observes the starter removal and installation. Check is made for tight bolts, tight teriminal connections, and correct electrical connections. When necessary, show the errors and weakness to the student. The student should be re-assigned the task to correct any errors and develop confidence in his ability to carry out the task.

2.9.13 Disassembling and Testing Starter

OBJECTIVE: Given a starter, the student must disassemble, test, and determine the condition of starter according to the manufacturer's recommendations.

EQUIPMENT:

- starter
- prowler
- test light (continuity)
- ohm meter (optional)

STUDENT ACTION: The student disassembles and tests the starter. The armature is checked with a growler and continuity tester. The fields are checked with a continuity tester for shorts and grounds. The condition of the brushes, bushings, and commutator are checked. Student makes recommendation of necessary rebuilding procedure and parts.

PERFORMANCE CHECK: The instructor checks the condition of the starter and determines if the student made the correct diagnosis and recommendation for rebuilding. Observe the students procedure of testing for shorts and grounds. If weakness is shown, determine if the student weakness is in testing or recommendations based on the testing. Explain the error and weakness to the student. Re-assign the task.

2.9.14 Diagnosing Faulty Solenoid

OBJECTIVE:	Given a faulty starter solenoid, the student must diagnose the solenoid malfunction and make the necessary repair according to manufacturer's specifications.
EQUIPMENT:	- faulty starter solenoid
STUDENT ACTION:	The student learns the characteristics of a faulty solenoid by sound and type of malfunction. Care is given to distinguish the malfunction from a weak battery. A check of the battery might be required to isolate the solenoid malfunction.
PERFORMANCE CHECK:	The instructor observes the student's performance to evaluate the student's diagnostic procedure. Determine if he isolated the solenoid malfunction correctly.

2.9.15 Removing and Replacing Solenoid

OBJECTIVE: Given a malfunctioning solenoid, the student must replace the solenoid according to the manufacturer's specifications.

STUDENT ACTION: On the basis of his evaluation in 2.9.14, the student replaces the solenoid. Care is given to disconnection of the battery and proper connecting of leads to terminals.

PERFORMANCE CHECK: The instructor observes the student's performance to determine if the student correctly assembles and connects the leads to the solenoid and starter. When necessary, re-assign the same task, and have student correct his mistake. Give needed information to correct procedure and understanding.

2.9.16 Diagnosing a Faulty Bendix

OBJECTIVE:	Given a faulty bendix in operation, the student must diagnose the malfunction and make the necessary repairs according to the manufacturer's specifications.
EQUIPMENT:	- faulty bendix - various types - set of tools
STUDENT ACTION:	The student disassembles the starter and replaces the bendix as well as visually inspecting the rest of the starter. Student should become familiar with several types of bendix and their disassembly-assembly procedures.
PERFORMANCE CHECK:	The instructor observes the student's diagnosis and rebuilding procedures. Determine if a competent level of diagnostic skill is evident. When necessary, assign further similar tasks to develop the skill of the student.

2.9.17 Orienting to Test Equipment - Charging System

OBJECTIVE: Given the necessary test equipment and orientation the student must correctly connect the test equipment for testing the charging system.

EQUIPMENT:

- Marquette model 42-148 tester (or the equivalent)
- a charging system

STUDENT ACTION: The student correctly connects the tester for testing a charging system. The student is familiar with all the tests of the machine, and knows how to connect the tester for all of the test situations.

PERFORMANCE CHECK: The instructor observes the student's procedure of hooking up the tester. The correctness of the connections is determined. If there is error, show the student the error. Explain the correct way. Assign remedial tasks of hooking up test equipment until student performs tasks accurately and effeciently.

RESOURCES: Manual supplied with test equipment.

2.9.18 Testing Charging System

OBJECTIVE:	Given the test equipment of 2.9.17 and a vehicle with a charging system, the student must test the charging system and evaluate its condition to the instructor's satisfaction.
EQUIPMENT:	· test equipment of 2.9.17 · a charging system
STUDENT ACTION:	The student makes the necessary tests to check the battery generator, or alternator and regulator on the unit being serviced. Evaluation is made of the condition. The battery is tested with hydrometer and load test (2.9.4 and 2.9.5). The starter draw is measured. Check is made of the voltage and amperage settings of the regulator.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student's data is accurate. The student's evaluation of the system should be in accord with the data. If data is in error, have student perform testing phase of task again. If evaluation phase is incorrect, review the bases on which judgement is made.
RESOURCES:	Manual on test equipment.

2.9.19 Removing and Replacing Generator (Alternator)

OBJECTIVE:	Given a unit with a charging system, the student must remove and replace the generator or alternator within the manufacturer's specifications.
EQUIPMENT:	- set of tools - unit w/charging system
STUDENT ACTION:	The student disconnects all electrical connections and removes the generator or alternator. Replacement is made with another generator (or the same one after rebuilding). Care is given to proper electrical hook up, belt tension, etc. (Generator-type system must be polarized according to manufacturer's recommendation.)
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student properly installed the rebuilt generator (alternator). Check that bolts are replaced and torqued, belt tension is correct, electrical connections are correct and secure, and the battery is reconnected. Show the student any errors or weaknesses. The student should correct his own mistakes under supervision of the instructor. Re-assign task.
NOTE:	The battery ground wire should be disconnected before starting the removal procedure.

2.9.20 Disassembling and Testing Alternator

OBJECTIVE:	Given an alternator, the student must disassemble and the alternator according to the manufacturer's specifications.
EQUIPMENT:	- an alternator - diode tester - ohm meter (continuity light)
STUDENT ACTION:	The student disassembles the alternator and tests the component parts. Check is made of stator windings, brushes and diodes. Necessary repairs are made and the alternator is reassembled.
PERFORMANCE CHECK:	The instructor observes the student's action and determines if the test results are accurate. Evaluate the student's judgment on the necessity of replacing parts. The student should correctly evaluate the components. If not, assign remedial tasks of testing alternators until a satisfactory degree of proficiency is established.

2.9.20

2.9.21 Disassembling and Testing Generator

OBJECTIVE: Given a generator, the student must disassemble and test the generator according to the manufacturer's specifications.

EQUIPMENT:

- generator
- ohm meter (continuity light)
- growler

STUDENT ACTION: The student disassembles the generator and tests the components. The armature, field coils, commutator and brushes are checked. The commutator is cleaned and under-cut and brushes are replaced if necessary. The generator is reassembled.

PERFORMANCE The instructor observes the student's action and determines if the tests are accurate. The student's judgment on the necessity of replacing of parts is evaluated. Explain areas of weakness to the student. Have student perform the task again.

2.9.22 Adjusting Regulator (Where Applicable)

OBJECTIVE:	Given an adjustable-type regulator, the student must adjust the regulator until the charging system meets the manufacturer's specifications.
EQUIPMENT:	- test equipment of 2.9.18 - charging unit with adjustable regulator
STUDENT ACTION:	The student makes the necessary tests and adjusts the regulator to control the voltage and amperage as specified by the manufacturer.
PERFORMANCE CHECK:	The instructor checks the generator output to determine if the student has adjusted the regulator to meet the manufacturer's specifications. If the student has not, isolate errors and weaknesses. Show the student the errors. Assign remediation of similar tasks until student is proficient at task.

2.9.23 Removing and Replacing Regulators

OBJECTIVE:	Given a unit with a generator type system, the student must remove and replace the regulator according to the manufacturer's specifications.
EQUIPMENT:	- a charging system equipped with a regulator
STUDENT ACTION:	The student disconnects and removes the regulator. Replacement is made with another regulator. Care is given to proper electrical hook-up. (If a generator-type system, the unit should be polarized.) Battery should be disconnected (ground wire) during the task.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student properly installed the regulator. Check electrical connections. Check polarization if a generator system. Show the student any errors. Student should correct errors and make necessary changes under close supervision. Another task should be assigned.

2.9.24 Replacing Light Bulbs

OBJECTIVE:	Given a faulty light bulb the student must replace the bulb to the manufacturer's specifications.
EQUIPMENT:	- variety of light sockets - replacement bulbs
STUDENT ACTION:	The student replaces the bulb after properly matching the bulb to the socket. Special emphasis is given to correctly connecting wires on headlights for proper functioning of "dim" and "bright". Also emphasized are double filament bulbs for brake and tail light combinations. The brake light is always the brightest.
PERFORMANCE CHECK:	The instructor observes the student to determine if the student properly installed the light and matched the bulb to the socket. When necessary, review the type of sockets and precautions. Give remedial task to develop the skill.

2.9.25 Diagnosing Turn Signal Malfunction

OBJECTIVE: Given a turn signal system with a malfunction, the student must diagnose the malfunction and correct it to the quality of original.

EQUIPMENT:

- test light
- necessary tools

SPECIAL PREPARATION: Instruction on the theory and function of turn signals. Emphasis is placed on the type of signal unit which eliminates the brake light during turn signal operation.

STUDENT ACTION: The student traces any malfunction to the source. Care is given to the operation of the signal switch in the steering column.

PERFORMANCE CHECK: The instructor observes the student's performance to determine if the student correctly located the malfunction. Evaluate the diagnostic procedure. As necessary, review the procedure of trouble shooting. Use individual instruction on the malfunctioning system to emphasize and demonstrate proper procedure.

2.9.26 Diagnosing Brake Light Malfunction

OBJECTIVE:	Given a brake light system with a malfunction, the student must diagnose the malfunction and correct it to the quality of the original.
EQUIPMENT:	- test light
SPECIAL PREPARATION:	Instruction on the theory and function of a brake light system (especially if connected to the turn signal system).
STUDENT ACTION:	The student trouble shoots the brake light system to locate the malfunction.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly trouble shoots a brake light system. Written or oral test of diagnostic procedure can check performance. The best performance check is a vehicle malfunction. As necessary, review the procedure of trouble shooting. Use individual instruction on a malfunctioning system to point out procedure.

2.10.0 Bearings and Bushings

Identifying bearings 2.10.1

Packing wheel bearings 2.10.2

Replacing seals 2.10.3

2.10.1 Packing Wheel Bearings

OBJECTIVE:	Given a vehicle which needs wheel bearings repacked, the student must remove and replace the wheel and pack the wheel bearing according to the manufacturer's specifications.
EQUIPMENT:	- wheel bearings in their application - axle grease - air supply - cleaning solvent - necessary tools
STUDENT ACTION:	The student properly jacks and blocks the vehicle for wheel removal. Wheels are removed and bearings cleaned with solvent. Bearings are thoroughly re-packed and installed. Wheels are replaced and bearings are pre-loaded to manufacturer's specifications.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the bearings were properly cleaned and repacked. Also the pre-load is checked. When necessary, the task should be re-assigned and the same job performed correctly. Instruction should be given specifically to areas of weakness.
RESOURCES:	Caterpillar Training Slides.

2.10.2 Identifying Bearings

OBJECTIVE:	Given a variety of bearings, the student must identify the types of bearing with 80% accuracy.
EQUIPMENT:	- ball bearings - roller bearings - tapered bearings - needle bearings - thrust bearings
SPECIAL PREPARATION:	Secure the above variety of bearings.
STUDENT ACTION:	The student identifies each type of bearing. The student should know the typical application of each type of bearing. The student should be aware of pre-load on tapered bearings.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student knows the type and application of each of the bearings. Use a written or oral exam with specific bearings to identify according to type and application. As necessary, provide time for continued study of type and application. Show specific application for interest and motivation. Re-test on type and application.

2.10.3 Replacing Seals

OBJECTIVE:	Given a new seal, the student must install the seal in the hub to the instructor's satisfaction.
EQUIPMENT:	- new seal - axle hub
STUDENT ACTION:	The student learns to remove the old seal (usually when the bearing is removed) and install the new seal. The student learns to install the lip of the seal toward the lubricant.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly installs the seal. Check is made for proper alignment. Also, check is made that the lip is installed in the right direction.

2.11.0 Hydraulic systems

Knowledge of the component parts 2.11.1

Changing oil and filter 2.11.2

Adjusting operating pressure 2.11.3

Replacing hydraulic hose 2.11.4

Rebuilding hydraulic cylinder 2.11.5

Replacing a valve 2.11.6

Replacing a pump 2.11.7

Diagnosing a faulty hydraulic system 2.11.8

2.11.1 Knowledge Of The Component Parts

OBJECTIVE:	Given the necessary information, the student must know the component parts of a hydraulic system and the function of each component part to 80% accuracy.
EQUIPMENT:	- the various parts of a hydraulic system
STUDENT ACTION:	The student learns to identify the component parts by sight. He learns the function of each and the flow of oil through the hydraulic system. He learns the indicators of major malfunctions of the component parts.
PERFORMANCE CHECK:	The instructor tests the student's knowledge of the hydraulic system. Check is made for identifcation of the components and for the function of each. Check is also made of the major indicators of malfunction and which specific part could be the cause.

2.11.2 Changing Oil & Filter

OBJECTIVE:	Given a hydraulic system, sufficient oil, and necessary filters, the student must service the hydraulic system by changing the filter(s) and filling with new oil to the manufacturer's specifications.
EQUIPMENT:	- oil filter replacement - sufficient quantity of replacement oil - necessary tools - container for draining
STUDENT ACTION:	The student drains the oil, changes the filter and fills with new oil of the manufacturer's specification. Care is given not to over-fill the unit. Precuations are taken to have any one-way cylinders at the proper position so the oil reservoir will not be over full.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly carries out the procedure. Check is made for correct oil level and no leaks. When necessary, review the procedure and specifications. Assign a similar task, or re-assign the same task, for remedial purposes.
RESOURCES:	Owner's Manual . . . see 2.5.1

2.11.3 Adjusting Operating Pressure

OBJECTIVE: Given a hydraulic system, the student must adjust the operating pressure to meet the manufacturer's specifications.

EQUIPMENT:

- pressure gauge and necessary fittings
- necessary tools

STUDENT ACTION: The student adjusts the operating pressure of the hydraulic system to meet the specifications of the manufacturer. Various types of relief valves are inspected for the type of operation and adjustment.

PERFORMANCE CHECK: The instructor observes the student's performance to determine if the student correctly adjusts the operating pressure. As necessary, re-assign the task or assign a similar task with close supervision. Give necessary instruction and demonstration for areas of weakness.

RESOURCES: Owner's Manual

2.11.4 Replacing Hydraulic Hose

OBJECTIVE: Given a variety of hoses and fittings, the student must remove and replace hoses to the instructor's satisfaction.

EQUIPMENT: - various hoses in application

STUDENT ACTION: The student removes and replaces a variety of different hoses to experience the proper procedure for replacement. Care is given to minimal twisting of hoses. Fittings which allow swiveling should be explained and demonstrated. The student should be able to approach a machine and figure out which end of the hose to remove first - that is which ones swivels.

PERFORMANCE CHECK: The instructor observes the student's performance to determine if the student correctly removes or replaces a hose. Oral testing can be done by having the student explain the procedure that he would use on a specific machine assigned by the instructor. Performance test by assigning a task with various fittings.

2.11.5 Rebuilding Hydraulic Cylinder

OBJECTIVE:	Given a hydraulic cylinder with internal or external leaks, the student must rebuild the cylinder according to the manufacturer's recommendations.
EQUIPMENT:	- hydraulic cylinder (s) - necessary tools
STUDENT ACTION:	The student disassembles, repairs, and assembles the hydraulic cylinder. A variety of cylinder types should be used and each member of the class required to disassemble each different type. Care is given to plug open lines for protection from dirt and excessive oil leakage.
PERFORMANCE CHECK:	The instructor observes the student to determine if the cylinder was properly overhauled. Proper function of the cylinder under load will indicate the competency of the skill. The student should correct any malfunction and bring the quality to the original.

2.11.6 Replacing A Valve

OBJECTIVE: Given a hydraulic system with a malfunctioning control valve, the student must replace the valve according to the manufacturer's specifications.

EQUIPMENT:

- replacement valve
- necessary tools
- plugs for lines
- additional oil

STUDENT ACTION: The student removes the malfunctioning valve from the unit and replaces it with another valve. Precaution is taken to protect the lines from dirt. The valve body and fittings should be properly cleaned before opening the system.

PERFORMANCE CHECK: The instructor observes the student's performance to determine if the student correctly removes and replaces the valve. Check to see that the valve functions properly. Cleanliness and oil loss are important checks. As necessary, assign a similar task and make suggestions for correcting the errors of previous task.

NOTE: It is possible that supply lines need to be evaluated to prevent oil being syphoned from the system.

2.11.7 Replacing A Pump

OBJECTIVE: Given a hydraulic system with a malfunctioning pump, the student must remove the pump and replace with another to the manufacturer's specifications.

EQUIPMENT:

- a replacement pump
- necessary tools
- plugs for the lines
- additional oil

STUDENT ACTION: The student removes the malfunctioning pump from the unit and replaces it with another pump. Precaution is taken to protect the system from dirt. The pump and hoses should be properly cleaned before opening the system.

PERFORMANCE CHECK: The instructor observes the student to determine the competency level of the task. Proper pump installation and function, with cleanliness and no leaks, indicates competency. When necessary, re-assign the task or assign a similar task. Make suggestions and give individual instruction for correcting errors.

NOTE: If is possible that supply lines need to be evaluated to prevent oil being syphoned from the system.

2.11.8 Diagnosing A Faulty Hydraulic System

OBJECTIVE:	Given an hydraulic system with a malfunction, the student must diagnose the malfunction to the instructor's satisfaction.
EQUIPMENT:	- unit with hydraulic system
SPECIAL PREPARATION:	Provide a unit with a malfunctioning hydraulic system. Possibly, it will have to be rigged.
STUDENT ACTION:	The student operates the malfunctioning hydraulic system to determine the characteristics of the system. Given the characteristics, the student makes a diagnosis of the probable component(s) which is malfunctioning.
PERFORMANCE CHECK:	The instructor observes and discusses the diagnostic process performed by the student. Determine if the characteristics of malfunction were properly established. If there are errors, determine if the errors were in determining characteristics or in evaluation of characteristics. Make remedial assignments accordingly for strengthening the procedure or evaluation.

2.12.0 Wire Rope

Identifying wire rope 2.12.1

Cutting wire rope 2.12.2

Clamping wire rope 2.12.3

Lubricating wire rope 2.12.4

Attaching and winding on a spool 2.12.5

2.12.1 Identifying Wire Rope

OBJECTIVE:	Given samples of wire rope (cable), the student must identify the cable as to size and type with 80% accuracy.	
EQUIPMENT:	- samples of wire rope	
STUDENT ACTION:	The student identifies the sampels of wire by the cross section.	
PERFORMANCE CHECK:	The instructor tests the student to determine if the student correctly identifies the samples of rope.	
RESOURCES:	Cable Maintenance & Reeving	M.210-14 M.310-25

2.12.2 Cutting Wire Rope

OBJECTIVE:	Given wire rope, cable cutter and sledge hammer, the student must cut the wire rope to the instructor's satisfaction.
EQUIPMENT:	- wire rope - cable cutters - sledge hammer
STUDENT ACTION:	The student cuts the cable to a specified length. The cable cutter must be placed on a hard surface to cut the cable.
PERFORMANCE CHECK:	The instructor determines by observation if the student correctly cuts cable.

2.12.3 Clamping Wire Rope

OBJECTIVE:	Given wire rope and cable clamps, the student must clamp the rope according to the cable manufacturer's specifications.
EQUIPMENT:	- a length of wire rope (5ft. minimum) - 3 cable clamps (size which matches the cable) - necessary tools
STUDENT ACTION:	The student clamps the cable with the supplies. All clamps should be placed in the same direction and securely tightened.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student has correctly completed the task. As necessary, explain area of error to student. Show correct procedure and re-assign task.
RESOURCES:	Cable Maintenance & Reeving M.210-14 M.310-25

2.12.4 Lubricating Wire Rope

OBJECTIVE:	Given a length of wire rope in its application, the student must lubricate the wire rope to the instructor's satisfaction and manufacturer's recommendations.
EQUIPMENT:	- wire rope in application - lubricant
STUDENT ACTION:	The student learns to dip and pour lubricant on wire rope.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly lubricates the rope.

2.12.5 Attaching and Winding Rope on a Spool

OBJECTIVE:	Given a winch spool and the necessary wire rope, the student must attach the wire rope with a wedge and wind the rope on the spool to meet the equipment manufacturer's specifications and the recommendations of the wire rope manufacturer.
EQUIPMENT:	- winch unit - necessary wire rope
STUDENT ACTION:	The student learns to attach the wire to the winch. He learns to install the wedge. The rope is then wound on the spool in the proper direction.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly attaches and winds the wire rope.

2.13.0 Drive Chains and Belts

Drive chains 2.13.1

Belts 2.13.2

2.13.1 Drive Chain

OBJECTIVE:	Given the necessary information, the student must identify the type and size of drive chain and demonstrate proper technique in removal and replacement to 80% accuracy.
EQUIPMENT:	- samples of drive chain - drive chains in their application
STUDENT ACTION:	The student learns to identify drive chain by size. (Roller, multiple strand roller, and inverted tooth). The student learns to uncouple the chain and to recouple. The proper tension and lubrication is learned. The student should learn the definition and use of chain pitch, i.e. The distance between the center lines of adjacent pins.
PERFORMANCE CHECK:	The instructor tests the student's knowledge with an identification test of types and sizes of drive chain. The student's performance is observed to determine if the student correctly installs drive chain. Check is made for correct tension and lubrication.
RESOURCES:	Chains and Belts, Student Workbook, M.004-6A SW-001, U.S. Army Engineer School, Fort Belvoir, Virginia.

2.13.2 Belts

OBJECTIVE: Given the necessary information, the student must identify belts by type and size and demonstrate proper technique in removal and replacement to 80% accuracy.

EQUIPMENT:

- a variety of belts
- belts in their applications

STUDENT ACTION: The student learns to identify belts by types (flat, troughed, and V-belts). The student should be able to identify sizes of belts, (V-belts are identified as a.b.c.d. and e). The student should learn to adjust the tension on belts. Also proper alignment of pulleys should be emphasized.

PERFORMANCE CHECK: The instructor tests the student's knowledge with an identification test of types and sizes of belts. The student's performance is observed to determine if the student correctly aligns and adjusts belts.

RESOURCES: Chains and Belts, Student Workbook, M.004-6A SW-001, U.A. Army Engineer School, Fort Belvoir, Virginia.

NOTE: When replacing belts of the same length, the whole set should be replaced.

2.14.0 Power Trains

Knowledge of power flow 2.14.1

Removing and replacing clutch 2.14.2

Removing and replacing transmission 2.14.3

Removing and replacing differential 2.14.4

Removing and replacing universal joint 2.14.5

Adjusting steering clutch and brakes 2.14.6

2.14.1 Knowledge of Power Flow

OBJECTIVE:	Given the necessary information, the student must know the component part and trace the power flow from the engine to the tracks or wheels of a specified piece of equipment to 80% accuracy.
STUDENT ACTION:	The student learns the names and function of the various parts of a power train. The student learns to identify by sight and state the purpose of such components as the clutch, transmission, differential, steering clutch and brake, and axle.
PERFORMANCE CHECK:	The instructor tests the student's knowledge with an identification test of the component parts of the power train. Check is made for the correct understanding of the purpose and function of the component parts..

2.14.2 Removing and Replacing Clutch

OBJECTIVE:	Given a clutch assembly in its application, the student must remove and replace the clutch assembly to the manufacturer's specifications.
EQUIPMENT:	- a clutch assembly in its application
STUDENT ACTION:	The student removes the necessary components to gain access to the clutch assembly. The necessary components vary from one application to another. In some cases the engine must be removed. In other cases the transmission must be removed. The student removes the pressure plates and clutch plate (s). Check is made for wear on clutch plate(s), warped or cracked pressure plate and flywheel, pressure plate spring tension, pilot bearing condition and clutch release bearing condition. The student learns to align the clutch plate with a pilot shaft during reassembly and adjust the free travel after assembly. The student should also be familiar with the adjustment of over-center style clutches.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly meets the objective. Check is made for correct evaluation of the condition of clutch plate, pressure plate, and bearing condition.
RESOURCES:	Equipment manufacturer's service manual
NOTE:	When flywheel is being removed, it is suggested that center punch marks be placed on the flywheel and crankshaft to mark the position of the flywheel. This expedites reassembly since most flywheels will fit in one position.

2.14.3 Removing and Replacing Transmission

OBJECTIVE:	Given a transmission in its application, the student must remove and replace the transmission to the manufacturer's specification.
EQUIPMENT:	- a transmission in its application.
STUDENT ACTION:	The student learns to remove the necessary component parts in preparation for removing the transmission. The necessary parts may include such items as drive shaft, engine, belly pan, cab, or other items depending on the application. The student learns the use of transmission jacks and hoists. Care is exercised in plugging and protecting oil and air lines to the transmission.
PERFORMANCE CHECK:	The instructor observes the student to determine if the performance meets the objective. Check is made for proper removal and replacement of other components. Also check is made for correct handling of transmission during removal and replacement.
RESOURCES:	Equipment manufacturer's service manual
CAUTION:	The transmission must slide into position. Do not use bolts to force the transmission housing to contact the engine housing.

2.14.4 Removing and Replacing Differential

OBJECTIVE: Given a differential in its application, the student must remove and replace the differential to the manufacturer's specifications.

EQUIPMENT:

- a differential in its application

STUDENT ACTION: The student learns to remove and replace the necessary components to gain access to the differential. The necessary components vary from one application to another. Examples of items are axles and drive shafts. The student learns to remove and replace the differential as a unit.

PERFORMANCE CHECK: The instructor observes the student's performance to determine if the student correctly removes and replaces the differential. Check is made for correct removal and replacement of the components which gave access to the differential.

NOTE: Some tractor applications become very involved. These are not intended to be dealt with in this manual.

2.14.5 Removing and Replacing Universal Joint

OBJECTIVE:	Given a drive shaft in its application, the student removes and replaces the drive shaft and installs new universal joints as necessary to the manufacturer's specifications.
EQUIPMENT:	- a drive shaft in its application
STUDENT ACTION:	The student learns to remove the drive shaft by removing the necessary parts of the universal joint. Care is taken to keep the needle bearings in the caps. The student learns to press the caps out of the yokes where necessary. New universals are installed (when necessary) and the drive shaft replaced.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly removes and replaces the universal joints and drive shaft. When necessary, make suggestions to aid the student.
RESOURCES:	Equipment manufacturer's service manual

2.14.6 Adjusting Steering Clutches and Brakes

OBJECTIVE:	Given steering brakes and clutches in their application, the student must adjust the clutch and brake assemblies to the manufacturer's specifications.
EQUIPMENT:	- steering clutches and brakes in their application
STUDENT ACTION:	The student learns to adjust the clutch linkage. Free travel is set at manufacturer's specification. The student learns to adjust the steering brakes. The student learns to tighten the brakes, leaving the specified amount of free travel. Adjusting procedures on foot operated brakes vary from procedures on lever operated brakes.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly adjusts the clutches and brakes. Check for solid contact and proper free travel. Offer constructive suggestions where necessary. Have student readjust as needed.
RESOURCES:	Equipment manufacturer's service manual

2.15.0 Tracks and Undercarriages

Adjusting track tension 2.15.1

Removing and replacing tracks 2.15.2

Removing and replacing pads 2.15.3

Removing and replacing rollers 2.15.4

2.15.1 Adjusting Track Tension

OBJECTIVE:	Given a track equipped machine, the student must adjust the tracks to the manufacturer's specifications.
EQUIPMENT:	- track equipped machine - straight edge (about 3' in length) - ruler
STUDENT ACTION:	The student learns to adjust tracks to the tension specified by the manufacturer. Usually the measurements of sag are made between the front sprocket and front roller.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly adjusts and measures the tension of the track. Offer helpful suggestions and have student correct errors where necessary.
RESOURCES:	Equipment manufacturer's service manual

2.15.2 Removing and Replacing Tracks

OBJECTIVE: Given a track equipped machine, the student must remove and replace the tracks to the manufacturer's specification.

EQUIPMENT: - a track equipped machine

STUDENT ACTION: The student learns to identify the master pin and remove it. It is suggested that the pin be in the lower front quarter of the front sprocket for removal. The machine is then backed off the tracks. Planks should be placed behind the tracks and the machine backed onto the planks. For replacement, the machine is driven onto the tracks. As the rear sprocket crawls on the track, the track must be lifted or tied so it wraps around the sprocket and is placed over the top roller.

PERFORMANCE CHECK: The instructor observes the student's performance to determine if the student correctly installs the tracks. Check is made for proper tension (2.15.1). When necessary, show the student errors or weaknesses and offer suggestions. Have the student correct his own errors.

RESOURCES: Equipment manufacturer's manual

NOTE: Make certain the tracks are installed in the forward position.

2.15.3 Removing and Replacing Pads

OBJECTIVE:	Given a track equipped machine, the student must remove and replace the pads to the manufacturer's specifications.
EQUIPMENT:	a track equipped machine
STUDENT ACTION:	The student learns to remove the old pad and replace the new one, using new bolts. The direction of the pad installation is important.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the pad is correctly installed and the bolts properly tightened.
RESOURCES:	Equipment manufacturer's service manual

2.15.4 Removing and Replacing Rollers

OBJECTIVE: Given a track equipped machine, the student must remove and replace the rollers to the manufacturer's specifications.

EQUIPMENT: - a track equipped machine

STUDENT ACTION: The student learns to remove the old rollers and replace with new rollers. The student learns the indicators of a worn roller and learns to make judgement on the need to replace rollers.

PERFORMANCE CHECK: The instructor observes the student's performance to determine if the student correctly removed and replaced the roller. As necessary make suggestions to the student and have the student correct anything necessary.

RESOURCES: Equipment manufacturer's service manual

BIBLIOGRAPHY

Fundamentals of Service, Deere and Company, Department F, John Deere Road, Moline, Illinois 61265

The following manuals are suggested:

- Electrical Systems
- Engines
- Fasteners
- Hydraulics
- Power Trains
- Shop Tools

Tractors and Crawlers, Philip V. Eshelman, American Technical Society, Chicago

Construction Equipment Operation (Programmed text), Department of Nonresident Instruction, U.S. Army Engineer School, Fort Belvoir, Virginia 22060

HEAVY EQUIPMENT OPERATION

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3.1.0 Pre-Operation Procedures

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Periodic check 3.1.2

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Visual inspection 3.1.4

Electric starting system 3.1.5

Gasoline starting motor system 3.1.6

International gas-start diesel-run system 3.1.7

Hand signals 3.1.8

3.1.1 Pre-Start Check

OBJECTIVE:	Given a piece of equipment, the student must check the coolant and lubricant levels and evaluate the condition of the piece of equipment before starting the engine.
EQUIPMENT:	- a piece of heavy equipment
STUDENT ACTION:	The student checks the level of the radiator coolant, engine oil, fuel, hydraulic fluid, and transmission, (if dipstick equipped). Knowing the level of the fluids, the student decides whether the equipment is in operating condition and if not, what corrections need to be made.
PERFORMANCE CHECK:	The instructor observes the level of the fluids and determines if the student's evaluations are correct. If necessary, review the procedure and discuss the cause for the incorrect evaluation.
RESOURCES:	Operator's Manuals

3.1.2 Periodic Check

OBJECTIVE:	Given a piece of equipment, the student must perform a periodic check of the battery electrolyte, transmission fluid (if not dipstick equipped), air cleaner condition, tire pressure (if rubber tire equipped).
EQUIPMENT:	- a piece of heavy equipment - necessary tools
STUDENT ACTION:	The student checks the condition of the fluids and components mentioned above. Knowing the condition of the fluids and components, the student decides whether the equipment is in operating condition, and if not, what corrections need to be made.
PERFORMANCE CHECK:	The instructor checks the level of the fluids and condition of the components. The instructor compares his data with the student's and determines if the student's evaluation is correct. If necessary, review the procedure, and discuss the cause for the incorrect evaluation.
RESOURCES:	Operator's Manual

3.1.3 Safety Check

OBJECTIVE:	Given a piece of equipment the student must make a safety check of transmission, attachments, and clutch before starting the equipment.
EQUIPMENT:	- a piece of heavy equipment to be operated.
STUDENT ACTION:	The student checks for neutral position of transmission, neutral position of attachments, and disengages the engine clutch before starting the engine. The student learns to check for disengagement of any lever so the machine or its attachments can not start moving and injure anyone.
PERFORMANCE CHECK:	The student's performance is observed to determine the level of skill. Periodic checking of the student will show if the skill is a consistant habit. This task should be retested periodically to insure that careless behavior has not occured. Where necessary, explain the errors and weakness to the student. Emphasize the importance of checking and give examples of possible accidents. Have student repeat the task.
RESOURCES:	Operator's Manual

3.1.4 Visual Inspection

OBJECTIVE:	Given a piece of equipment, the student must make a visual inspection of the equipment for such items as flat tires, loose guards, broken parts, and leaks to the instructor's satisfaction.
EQUIPMENT:	- a piece of equipment
STUDENT ACTION:	The student makes a thorough visual inspection of the piece of equipment. He looks for such items as are listed above. He determines the condition of the piece of equipment and evaluates its "readiness" to operate.
PERFORMANCE CHECK:	The instructor assigns a piece of equipment to the student either for checking or for operation. The student must make a visual inspection and evaluate the equipment's condition. Inspect the piece of equipment and determine the quality of the student's evaluation. Where necessary, determine the errors and/or weaknesses of the student. Explain them to the student. Reassign the task and retest.
RESOURCES:	Owners' Manual.

3.1.5 Electric Starting System

OBJECTIVE:	Given a piece of heavy equipment equipped with an electric starter, the student must start the unit to the instructor's satisfaction.
EQUIPMENT:	- a piece of heavy equipment
STUDENT ACTION:	The student learns to identify different styles of ignition switches and their operations. Likewise various types of starter switches are identified. The student becomes proficient at starting a variety of units equipped with ignition switch, starter switch, and direct starting electric starter.
PERFORMANCE CHECK:	The instructor assigns the task to be done. The student is observed to determine the correctness of the skill. Check for proper period of rest and cooling if the starter is used for a length of time. This prevents overheating of the starter. Where necessary, isolate the error of the student. Review the identification of types of switches. Explain other weaknesses. Reassign the task.
RESOURCES:	Operator's Manual

3.1.6 Gasoline Starting Motor System

OBJECTIVE: Given a piece of heavy equipment with a gasoline motor for starting the diesel, the student must start the unit to the instructor's satisfaction.

EQUIPMENT: Caterpillar diesel with gasoline starting motor

STUDENT ACTION: The student learns the purpose of all the controls (decompression, pinion, clutch, etc.) and their sequence of operation. The gasoline engine is started with the electric starter. The compression is released on the diesel engine. The pinion is engaged, then the clutch. After the diesel engine is turning, the compression lever is engaged. When the engine starts, the clutch and pinion are disengaged.

PERFORMANCE CHECK: The instructor checks the student's performance to determine the level of competency. Assign the task to the student and observe for the proper sequence as stated above. Where necessary, determine the errors and weaknesses. Explain them to the student. Provide opportunity for practice. Re-assign the task and re-test.

RESOURCES: Operator's Manual

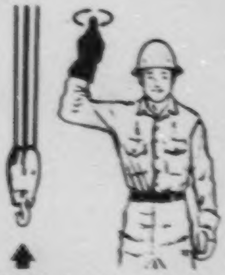
3.1.7 International Gas-Start Diesel-Run System

OBJECTIVE:	Given a piece of heavy equipment with an International engine that starts on gasoline and switches to diesel, the student must start the unit according to the manufacturers specifications.
EQUIPMENT:	- an older style International diesel
STUDENT ACTION:	The student learns the purpose of all the controls (gasoline chamber lever, starter lever, gasoline throttle, etc.) and the proper sequence to start the unit. The engine is switched to gasoline. The starter is engaged and the engine choked. After the engine is running on gasoline, it is switched to diesel by simultaneously closing the gasoline chamber and opening the diesel throttle.
PERFORMANCE CHECK:	The instructor observes the student to determine the level of competency. Assign the task and check for the proper sequence as stated above. Where necessary, determine the errors and weaknesses of the student. Review the function and sequence of the controls. Re-assign the task and re-test.
RESOURCES:	Operator's Manual

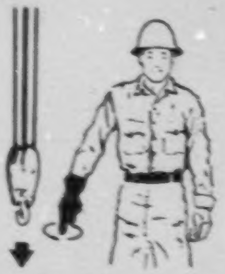
3.l.8 Hand Signals

OBJECTIVE:	Given a set of hand signals, the student must learn those signals to 80% accuracy.
EQUIPMENT:	- set of hand signals (appendix 3.l.8a)
STUDENT ACTION:	The student learns the hand signals (appendix 3.l.8a) for hoisting, lowering, raising boom, lowering boom, stop, track travel, and "inching".
PERFORMANCE CHECK:	The student's knowledge of hand signals is tested by written pictorial exam and oral visual exam. Determine the student's errors. Re-assign the learning task. Allow time for study and re-test.

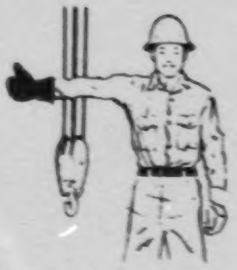
KNOW YOUR HAND SIGNALS



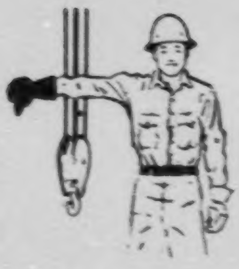
HOIST. With forearm vertical, forefinger pointing up, move hand in small horizontal circle.



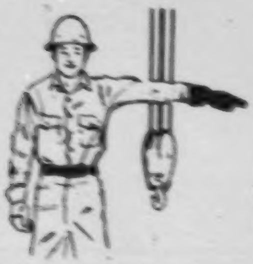
LOWER. With arm extended downward, forefinger pointing down, move hand in small horizontal circles.



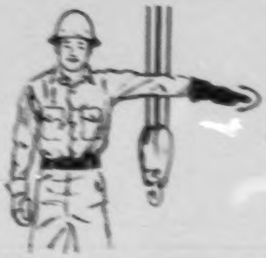
RAISE BOOM. Arm extended, fingers closed, thumb pointing upward.



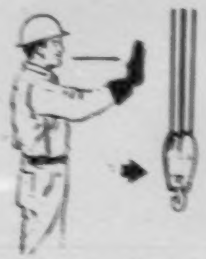
LOWER BOOM. Arm extended, fingers closed, thumb pointing downward.



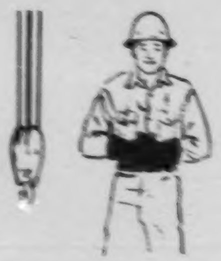
STOP. Arm extended, palm down, hold position rigidly.



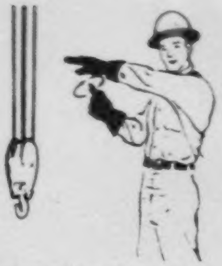
EMERGENCY STOP. Arm extended, palm down, move hand rapidly right and left.



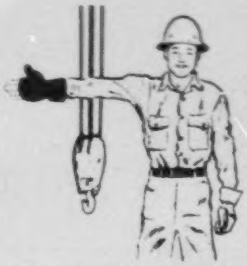
TRAVEL. Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.



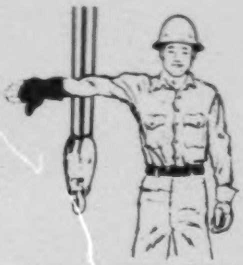
DOG EVERYTHING. Clasp hands in front of body.



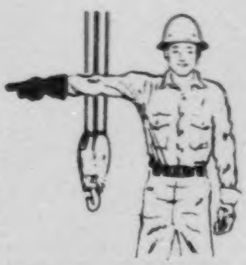
MOVE SLOWLY. Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist slowly shown as example.)



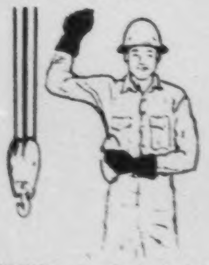
RAISE BOOM/LOWER LOAD. With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.



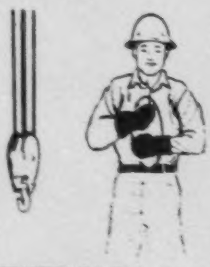
LOWER BOOM/RAISE LOAD. With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.



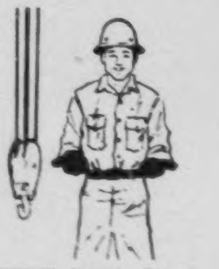
SWING. Arm extended, point with finger in direction of swing of boom.



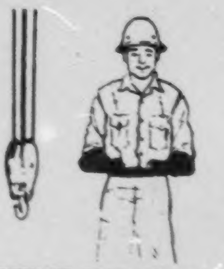
TRAVEL. *(One Track.)* Lock the track on side indicated by raised fist. Travel opposite track in direction indicated by circular motion of the other fist, rotated vertically in front of body. *(For crawler cranes only.)*



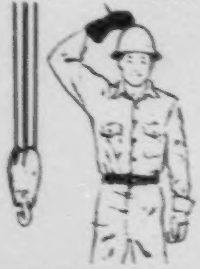
TRAVEL. *(Both Tracks.)* Use both fists in front of body, making a circular motion about each other, indicating direction of travel; forward or backward. *(For crawler cranes only.)*



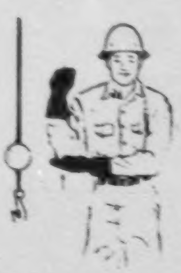
EXTEND BOOM. *(Telescoping Booms.)* Both fists in front of body with thumbs pointing outward.



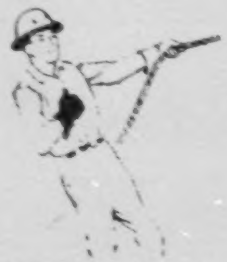
RETRACT BOOM. *(Telescoping Booms.)* Both fists in front of body, with thumbs pointing toward each other.



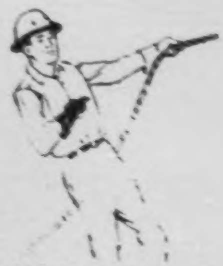
USE MAIN HOIST. Tap fist on head; then use regular signals.



USE WHIP LINE. *(Auxiliary Hoist.)* Tap elbow with one hand; then use regular signals.



EXTEND BOOM. *(Telescoping Boom.)* One fist in front of chest with thumb tapping chest.



RETRACT BOOM. *(Telescoping Boom.)* One fist in front of chest, thumb pointing outward and heel of fist tapping chest.

3.2.0 Fork Truck

Learning controls of fork truck 3.2.1

Picking up pallet with fork truck 3.2.2

Moving pallet from one location to another 3.2.3

Completing final test (fork truck) 3.2.4

3.2.I Learning Controls Of Fork Truck

OBJECTIVE:	Given a fork truck, the student must know the controls for operation to 100 % accuracy.
EQUIPMENT:	- a fork truck
STUDENT ACTION:	The student learns the function and operation of each control. The student learns which direction to move a lever to obtain the desired response. Foot pedals, transmission controls, and fork control levers are learned.
PERFORMANCE CHECK:	The instructor must observe the student's operation. Knowledge of the controls is checked with written pictorial identification, or oral exam. If necessary, review the operation of the controls which are not known. Allow the student to operate and experiment with the controls. Retest.
RESOURCES:	Operator's Manual

3.2.2 Picking Up Pallet With Fork Truck

OBJECTIVE: Given a fork lift and pallet, the student must align the fork lift with the pallet and pick it up within two attempts.

EQUIPMENT:
- a fork truck
- a pallet

STUDENT ACTION: The student learns to align the fork truck with the pallet. The characteristics of rear wheel steering are learned. The student learns to center the front wheels of the fork lift in line with the center of the pallet and then straighten the fork truck to the pallet.

The student properly positions the pallet on the forks, that is, pallet centered and as close to the rear as possible.

PERFORMANCE CHECK: The instructor observes the student's performance by checking for good alignment before lifting the pallet, (also check) for proper positioning of the load. Explain any observed error or weakness to the student. Show the proper way. Give helpful suggestions and allow the student to practice. Re-test.

3.2.3 Moving Pallet From One Location To Another

OBJECTIVE: Given a fork lift and a pallet, the student must move the pallet from one location to another, placing the pallet within ± 6 inches of a prescribed location in two attempts.

EQUIPMENT:
- a fork lift
- a pallet
- a specific location (possible a truck)

STUDENT ACTION: The student moves the pallet from one location to another (truck to floor, floor to truck, truck to truck, etc.). The load is positioned in the center and as close to the rear as possible. The load is carried as low as possible during transportation to reduce the possibility of tipping. The pallet is positioned within ± 6 inches of a place prescribed by the instructor.

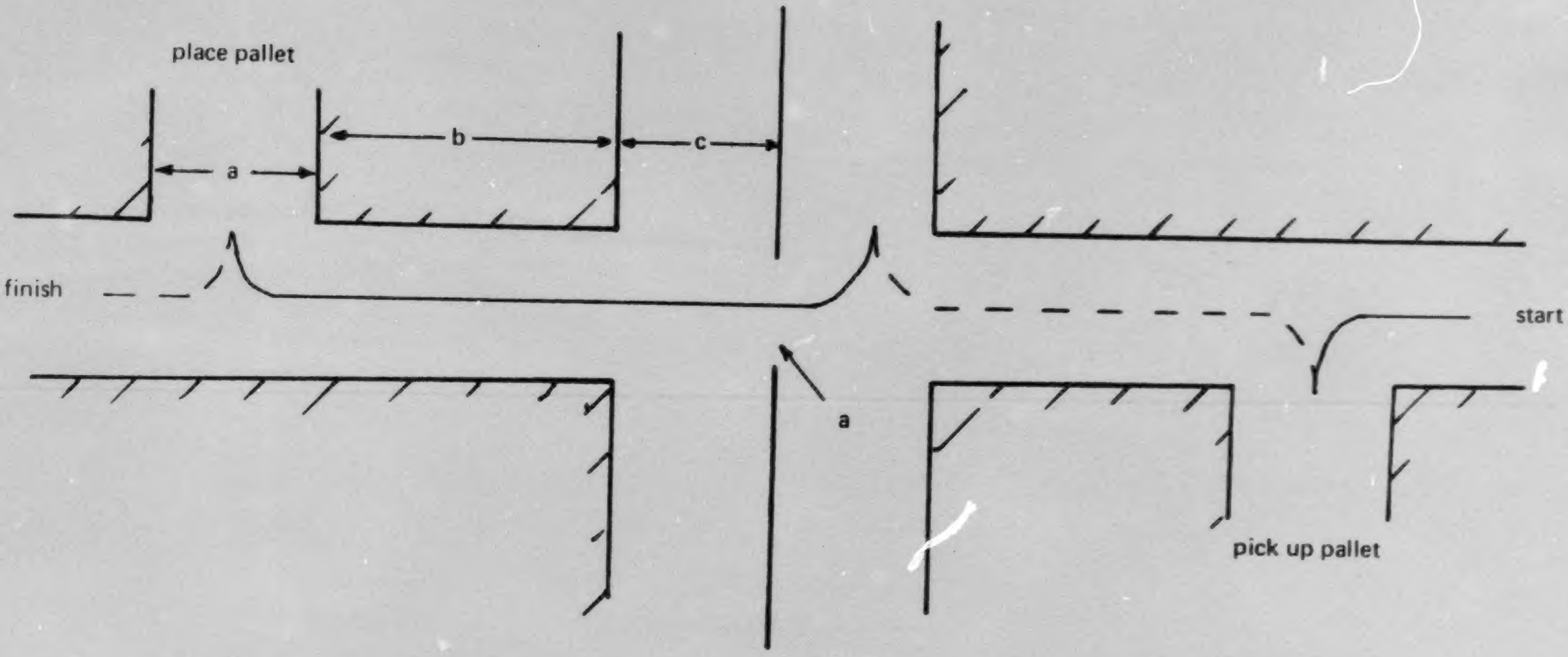
PERFORMANCE CHECK: The instructor observes the student's action by checking for the position of the load on the forks, the position in which the load is carried, and the general safety of operation. Determine if the pallet is placed in the specified location. When necessary, explain weaknesses or error to the student. Review the correct procedure. Allow opportunity for practice. Reassign the task and re-test.

3.2.4 Completing Final Test - Fork Truck

OBJECTIVE:	Given a fork lift and the obstacle course of appendix 3.2.4a, the student must complete the exercise in three minutes.
EQUIPMENT:	- fork truck - pallet with load 10-12′ wide - safety cones, or some means of simulating boundaries of the exercise.
STUDENT ACTION:	The student learns fork lift operation in a simulated warehouse setting. He picks up the pallet, backs down the aisle, maneuvers through the narrow opening, proceeds down the next aisle, places the pallet and backs to the finish point. Skill is developed in maneuvering in tight situations. The student develops the "feel" of rear wheel steering.
PERFORMANCE CHECK:	The instructor assigns the task and observes the student's performance. The student should safely maneuver the course within the specifications. Where necessary, show the student the weakness that causes him not to meet the specifications. Give opportunity for practice. Re-assign the task and re-test.

FORK LIFT TEST

3.2.4a


place pallet
a
b
c
finish
start
a
pick up pallet

P = width of pallet
F = width of fork truck
a = P + 2 feet
b = 2P
c = 1.5P or 1.5F (which ever is wider)

backward — — —

forward ————

3.3.0 Crane

Learning controls of shop crane 3.3.1

Learning controls of track crane 3.3.2

Learning to position boom 3.3.3

Attaching chain or cable for hoisting 3.3.4

Hoisting and moving load (shop crane or track crane) 3.3.5

Drag bucket operation 3.3.6

Clamshell operation 3.3.7

Setting beams 3.3.8

3.3.1 Learning Controls of Shop Crane

OBJECTIVE: Given a shop crane (cherry picker), the student must know the controls for operations to 100% accuracy upon command (voice or hand signals) of the instructor.

EQUIPMENT:

- shop crane

STUDENT ACTION: The student learns the function and operation of each control. The student learns which direction to move a lever to obtain the desired response. Foot pedals, transmission controls and crane controls are learned.

PERFORMANCE CHECK: The instructor checks the student's knowledge of the controls with written pictorial identification or oral exam. The student is placed in an operating situation and given specific commands or hand signals. The student should respond according to the specifications. The instructor should observe ths student and note the weaknesses and errors. Explain the weaknesses with helpful suggestions for correction. Give opportunity for practice. Re-assign task and re-test.

RESOURCES: See 3.1.8

3.3.2 Learning Controls Of Track Crane

OBJECTIVE:	Given a track crane, the student must know the controls for operation of the machine to 100% accuracy upon command (voice or hand signals) of the instructor.
EQUIPMENT:	- a track crane
STUDENT ACTION:	The student learns the function and operation of each lever or control. The student learns which direction to move a lever to produce the desired response of the machine. Proper sequence and coordination of foot controls with hand controls are learned. Transmission and ground movement controls are learned.
PERFORMANCE CHECK:	The instructor tests the student's knowledge of the controls by a written pictorial identification test, or with an oral exam. The student must demonstrate the correct lever movement in response to the hand signals of the instructor. Where necessary, explain errors or weaknesses to the student. Allow the student to practice. Re-assign the task and re-test.
RESOURCES:	Crane Shovels and Attachments, M. 001 - E2 - PT - 002

3.3.3 Learning To Position Boom

OBJECTIVE:	Given a crane and a load, the student must hoist a load with the boom at a safe angle and in accord with the manufacturer's recommendations.
EQUIPMENT:	- crane - load - operation manual
STUDENT ACTION:	The student learns the proper setting of the boom for the job. The boom is kept within the safe operating range (below a 78 degree angle, see RESOURCES). The machine capabilities are known, that is the load capacities at various boom angles and the radius at those angles. The student learns the "feel" of the machine as to how much weight it can lift as specific boom settings.
PERFORMANCE CHECK:	The instructor assigns the task and observes the student's performance. Observation is made to determine if the student is lifting too much weight with the boom extended. (With a shop crane, an exercise where the machine slightly tips is in order. On a large crane, the student has to learn the "feel" of the machine). Where necessary, show the student the errors and weaknesses. Explain the weaknesses with helpful suggestions for correction. Give opportunity for practice. Re-assign task and re-test.
RESOURCES:	Crane Shovels and Attachments, U.S. Army Engineer School M. 001 - E2 - PT - 002.

3.3.4 Attaching Chain Or Cable for Hoisting

OBJECTIVE: Given a crane and a load to be hoisted, the student must attach a chain or cable to the equipment and hoist the load safely to the instructor's satisfaction.

EQUIPMENT:

- crane
- load
- chain and/or cable

STUDENT ACTION: The student learns to find secure hitch points for attaching the chain or cable to the load. If none are available he has to make a sling. He attaches the chain or cable to the load and hooks it to the crane. The slack is removed and visual check is made for approximate balance of the load. The load is slowly hoisted. If the balance is good, the load is moved. If not, the hoist is lowered, the chain is slacked and the load is re-distributed by lengthening and/or shortening the chains. The chain or cable must be secured to the block so it can not slide and change the balance of the load.

PERFORMANCE CHECK: The instructor observes the student's performance. Check is made for proper hitch points. Observe the balance of the load and the safety with which it can be hoisted. When necessary, show the errors and weaknesses to the student. Explain a better way or let the student determine what would work better. Give student opportunity to correct the work. Re-assign task and re-test.

3.3.5 Hoisting & Moving Load (Shop Crane Or Track Crane)

OBJECTIVE:	Given a load and a crane, the student must move a load from one location to another and place the load in a specified location within ± one foot.
EQUIPMENT:	- crane - load
STUDENT ACTION:	The student must hoist a load and move it to the desired location (on a dock, a truck, a pallet, the ground, etc.) The load is set in a specified place according to the specifications. The load is carried as low as possible to minimize the damage if it should accidently drop.
PERFORMANCE CHECK:	The instructor assigns the task and observes the operation. to determine if the operation is done safely and to the specifications. The platform of the crane should be turned slowly to avoid excessive swinging of the load. When necessary show the student his errors and weaknesses. Provide opportunity for practice. Re-assign and re-test.

3.3.6 Drag Bucket Operation

OBJECTIVE:	Given a crane with a dragbucket, the student must operate the drag bucket and move dirt, making cuts to within ± 6 inches of the specifications.
EQUIPMENT:	- crane equipped with a drag bucket
STUDENT ACTION:	The student learns to simultaneously operate the clutches and brakes which control the drag bucket. For example, the hoist clutch and brake are used to maintain the depth of the cut while the bucket is pulled toward the machine. The full bucket is then dumped in a specified location.
PERFORMANCE CHECK:	The student's performance is observed to determine if the operation is within the specifications. Check should be made for proper use of equipment.
RESOURCES:	Operator's Manual
CAUTION:	It is suggested that the student keep one hand on the "swing" clutch at all times, and alternate the other hand between the "hoist" and "drag" clutch levers.

3.3.7 Clamshell Operation

OBJECTIVE:	Given a crane with a clamshell, the student must move the payload from one place to another and dump it to the instructor's satisfaction.
EQUIPMENT:	· crane equipped with a clamshell
STUDENT ACTION:	The student learns to fill the clamshell with payload, hoist the clamshell, and dump the payload in a specified location. The student learns to use both hoists simultaneously when lifting the clamshell, since the hoist and clamshell control cables are usually strung through different size blocks and operate at different speeds.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the performance is within the specifications. Check should be made for proper and safe use of crane.

3.3.8 Setting Beams

OBJECTIVE:	Given a crane and a beam or girder, the student must set the beam or girder to the specifications.
EQUIPMENT:	· crane · beam or girder
SPECIAL PREPARATION:	Provide a place and specifications for setting beams.
STUDENT ACTION:	The student learns to attach the crane to a beam or girder. Then he hoists the beam and carefully sets the beam in place. Other students can help guide the beam with short pieces of cable or chain.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the performance is within the specifications. Check should be made for proper and safe operation.
CAUTION:	Use extreme caution and slow movement since men on the ground have to hlep place the beam.

3.4.0 Crawler Tractor

Learning controls of crawler tractor - manual shift 3.4.1

Learning controls of crawler tractor - power shift 3.4.2

Pushing trees 3.4.3

Pulling trees 3.4.4

Piling brush 3.4.5

Making a cut to a specified grade 3.4.6

Making a fill to a specified grade 3.4.7

Filling a pond 3.4.8

Pushing a scraper 3.4.9

Winching equipment 3.4.10

3.4.I Learning Controls of Crawler Tractor - Manual Shift

OBJECTIVE:	Given the necessary information, the student must know the controls for the operation of the crawler tractor to 100% accuracy.
EQUIPMENT:	- operator's manual for the specific tractor - crawler tractor with gear type transmission
STUDENT ACTION:	The student learns the function and operation of each control. The student learns which direction to move a lever to produce the desired response of the machine. Proper usage of clutch, throttle, brake, transmission controls, shuttle, blade, winch, and steering clutches is emphasized.
PERFORMANCE CHECK:	The instructor determines the student's knowledge of the controls by giving a written pictorial identification exam, or by observation of the student's response when given an oral command for a specific function. For example, when told to "lower the blade" or "turn left". The student should correctly perform [illegible] desired operation. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Re-assign task and re-test.
RESOURCES:	Operator's Manual
NOTE:	Both steering clutches should not be disengaged at the same time.

3.4.2 Learning Controls of Crawler Tractor - Power Shift

OBJECTIVE:	Given the necessary information, the student must know the controls for the operation of the crawler tractor to 100% accuracy.
EQUIPMENT:	- operator's manual for the specific tractor - crawler tractor with power shift
STUDENT ACTION:	The student learns the function and operation of each control. The student learns which direction to move a lever to produce the desired response of the machine. Proper usage of throttle, brake, transmission controls, blade, winch, and steering clutches is emphasized.
PERFORMANCE CHECK:	The instructor determines the student's knowledge of the controls by giving a written pictorial identification exam, or by observation of the student's response when given an oral command for a specific function. For example, when told to "lower the blade" or "turn left". The student should correctly perform the desired operation. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Re-assign task and re-test.
RESOURCES:	Operator's Manual
NOTE:	Both steering clutches should not be disengaged at the same time.

3.4.3 Pushing Trees

OBJECTIVE: Given a blade equipped crawler tractor and a standing tree, the student must push out the tree to the instructor's satisfaction.

EQUIPMENT:

- blade equipped dozer
- standing tree (s)

SPECIAL PREPARATION: Provide an area with trees

STUDENT ACTION: The student learns to push out trees. The skill is taught for two sizes of trees.

Small trees: The student is taught to ease into the tree with the blade at the full height of its travel.

Larger trees: The student is taught to push dirt and roots away from the base of the tree. Then a mound of dirt is built on one side of the tree. The pushing is done from the mound to give the dozer more leverage against the tree.

PERFORMANCE CHECK: The instructor observes the student's performance specified above. Measurement is made by assessing the degree to which the student follows the proper technique as taught by the instructor. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Re-assign task and re-test.

3.4.4 Pulling Trees

OBJECTIVE:	Given a winch equipped crawler tractor and a standing tree, the student pulls over the tree to the instructor's satisfaction.
EQUIPMENT:	- standing tree - winch equipped dozer
STUDENT ACTION:	The student learns to pull out trees. Skill is taught in hooking the winch line to the tree at the proper height. Positioning of the dozer at a safe distance is mandatory. The student learns to hold the dozer in place as the winch line is pulled. This may be accomplished by lowering the blade and digging the tracks into the ground.
PERFORMANCE CHECK:	The instructor observes the student's performance. Measurement is made by assessing the degree to which the student follows the proper technique as taught by the instructor. Check is made for proper hitching to the tree and safe operating distance. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Re-assign task and re-test.
CAUTION:	The location of the tractor from the tree must be at a distance which is greater than the height of the trees.

3.4.5 Piling Brush

OBJECTIVE:	Given a dozer and fallen trees which need to be moved, the student must push the trees with a minimum of dirt to the specified location to the instructor's satisfaction.
EQUIPMENT:	- crawler tractor with dozer blade - fallen trees
STUDENT ACTION:	The student lerans to use the dozer blade to pile trees and brush which have been removed. Proper blade height is maintained to keep the blade out of the dirt, and to avoid rolling over the trees and brush.
PERFORMANCE CHECK:	The instructor observes the student's performance. Measurement is made by assessing the degree to which the student follows the proper techinque as taught by the instructor. The piled brush should contain a minimum amount of dirt. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Re-assign task and re-test.

3.4.6 Making A Cut To A Specified Grade

OBJECTIVE:	Given a crawler tractor equipped with a dozer blade and a set of grade stakes to follow, the student must cut away dirt to the given specifications within +0.75 ft.
EQUIPMENT:	- crawler tractor with dozer blade - area in which to move dirt - transit, level, or hand level - target rod
SPECIAL PREPARATION:	Provide a set of specifications for the student to follow.
STUDENT ACTION:	The student learns to use the dozer blade to pile trees and brush which have been removed. Proper blade height is cut and maintain the depth of the cut while the tractor crawls into the area of the fresh cut.
PERFORMANCE CHECK:	The instructor observes the student performance in relation to the objective. The depth of the cut is measured and compared to the grade stakes. The uniformity of the surface is also measured and assessed in relation to the specifications. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Re-assign task and re-test.

3.4.7 Making A Fill To A Specified Grade

OBJECTIVE:	Given a crawler tractor equipped with a dozer blade and a set of grade stakes to follow, the student must make a fill to given specifications within +0.75 ft.
EQUIPMENT:	- crawler tractor with dozer blade - area in which to move dirt - transit, level, or hand level - target rod
SPECIAL PREPARATION:	Provide a set of specifications for the student to follow.
STUDENT ACTION:	The student learns to control the dozer blade to make the desired fill. The dirt is worked from the solid base out to the fill.
PERFORMANCE CHECK:	The instructor observes the student's performance in relation to the objective. The elevation of the fill is measured and compared to the grade stakes. The uniformity of the surface is also measured and assessed in relation to the specifications. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Re-assign task and re-test.

3.4.8 Filling A Pond

OBJECTIVE:	Given a pond and a crawler tractor equipped with a dozer blade, the student must drain the pond and fill it with dirt to the instructor's satisfaction.
EQUIPMENT:	- crawler tractor with dozer blade - a pond
STUDENT ACTION:	The student learns to drain the pond by cutting through the levee or earthen dam. After the pond is drained, it is filled with dirt. Care is exercised to avoid getting the crawler stuck as dry dirt is worked into the wet area of the pond.
PERFORMANCE CHECK:	The instructor observes the student's performance. Assessment of the student's performance is made. The student should work through each phase of filling one pond. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Reassign task and re-test.

3.4.9 Pushing A Scraper

OBJECTIVE:	Given a crawler tractor equipped with a dozer blade and a scraper, the student must ease the dozer into the scraper and push the scraper while it loads.
EQUIPMENT:	- a crawler tractor with a dozer blade - a scraper loading
STUDENT ACTION:	The student learns to get behind the scraper and aid the loading process without undue shock to either piece of equipment. The student matches the speed of the scraper with the dozer. Where possible, the dozer can approach the scraper from an angle to make contact more gently.
PERFORMANCE CHECK:	The instructor observes the student action. Measurement is made by assessing the degree to which the student displays proper technique as taught by the instructor. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Re-assign task and re-test.

3.4.10 Winching Equipment

OBJECTIVE:	Given a piece of equipment (dead or stuck) and a winch equipped dozer, the student must pull that piece of equipment to the instructor's satisfaction.
EQUIPMENT:	- a winch equipped dozer - a piece of equipment to be moved
STUDENT ACTION:	The student attaches the cable to a recommended hitching point on the piece of equipment. The dozer is held in place and the piece of equipment is winched.
PEROFRMANCE CHECK:	The instructor observes the student performance. Check is made for a proper hitch point and proper use of equipment. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Re-assign task and re-test.

3.5.0 Industrial Tractor

Learning controls of industrial tractors 3.5.1

3.5.1 Learning Controls Of Industrial Tractor

OBJECTIVE:	Given an industrial type tractor, the student must know the controls for operation of the machine to 100% accuracy.
EQUIPMENT:	- an industrial tractor - operator's manual
STUDENT ACTION:	The student learns the controls of an industrial-type rubber tired tractor. The student learns which direction to move a lever to produce the desired response of the machine. Proper usage of throttle, brake, transmission controls, clutch, and shuttle are emphasized.
PERFORMANCE CHECK:	The instructor determines the student's knowledge of the controls by giving a written pictorial identification exam or by observation of the student's response when given an oral command for a specific function (for example, "use first gear" or "use high reverse"). The student should correctly perform the desired operation. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Re-assign task and re-test.
RESOURCES:	The Operator's Manual for the specific tractor

3.6.0 Front Loader

Learning controls of front end loader	3.6.1
Filling trench with front loader	3.6.2
Loading a truck	3.6.3
Digging a basement or pit	3.6.4

3.6.I Learning Controls Of Front End Loader

OBJECTIVE:	Given the necessary information, the student must learn the controls of the machine to 100% accuracy.
EQUIPMENT:	- a front end loader - the operator's manual
STUDENT ACTION:	The student learns the function and operation of each control. The student learns which direction to move a lever to produce the desired response of the machine. Proper usage of boom and bucket controls is emphasized. The controls of transmission, brakes, clutch, throttle, etc. are also learned.
PERFORMANCE CHECK:	The instructor determines the student's knowledge of the controls by giving a written pictorial identification exam, or by observation of the student's response when given an oral command for a specific function. When necessary, explain the error and/or weakness to the student. Allow time for review and practice. Re-assign task and re-test.
RESOURCES:	The Operator's Manual for the specific piece of equipment

3.6.2 Filling Trench With Front Loader

OBJECTIVE: Given a front end loader and an open trench with the necessary dirt lying beside the trench, the student must push the dirt into the open trench and "mound" the dirt over the trench to the instructor's satisfaction.

EQUIPMENT:

- a trench with dirt beside it
- a front end loader

STUDENT ACTION: The student fills the trench with the dirt which was piled near the trench during excavating; The front bucket of the backhoe, or a similar front end loader is used to push the dirt into the trench. The student learns to position the bucket with the bottom flat and scoop dirt. The dirt is pushed toward the trench and the boom raised and bucket dumped. Excess dirt is piled in a mound over the trench for settling purposes.

PERFORMANCE CHECK: The instructor determines by observation if the student correctly positions the bucket and moves the dirt to the trench. Check is made for uniform coverage. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Re-assign task and re-test.

3.6.3 Loading A Truck

OBJECTIVE:	Given a front loader and a stock pile of material, the student must load a truck with the material to the instructor's satisfaction.
EQUIPMENT:	- a front loader - a stock pile of material (dirt, gravel, sand) - a truck
STUDENT ACTION:	The student moves the material from the stock pile to the truck. The student learns to position the bucket level and lower it to the ground; to drive into the pile of material, curl the bucket, and raise the boom while still moving forward; and to raise bucket and position it over the truck. The dumping of the bucket should place the material in center of the bed so the load is evenly distributed.
PERFORMANCE CHECK:	The instructor observes the student action and makes assessment according to the specifications. Check is made for technique in loading the bucket, dumping the bucket, and proper loading of the truck. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Re-assign task and re-test.
CAUTION:	Care is used not to hit the truck with the front of the loader or the bucket during loading.

3.6.4 Digging A Basement Or Pit

OBJECTIVE:	Given a front bucket-type loader and the necessary specifications student must dig a pit to the required specifications.
EQUIPMENT:	- a front bucket-type loader or crawler - necessary place and specifications
STUDENT ACTION:	The student digs the pit to the specifications. He is taught to pile the dirt so it will be out of the way of further digging, yet not cause excessive moving distance. The student learns to work in the pit making the corners square and sides straight, and leave a place to drive his machine out of the pit.
PERFORMANCE CHECK:	The instructor observes the student's performance and assesses it in relation to the objective. Check is made for accuracy. Determine if the student planned ahead and can conveniently drive the machine out of the pit. When necessary, explain the errors or weaknesses to the student. Allow time for review and practice. Re-assign task and retest.

3.7.0 Backhoe

Learning controls of backhoe 3.7.1

Aligning backhoe 3.7.2

Digging trench 3.7.3

Digging a pit 3.7.4

3.7.I Learning Controls of Backhoe

OBJECTIVE: Given the necessary information, the student must know the controls for operation of the machine to 100% accuracy.

EQUIPMENT:
- operator's manual
- backhoe

STUDENT ACTION: The student learns the function and operation of each control. The student learns which direction to move a lever to produce the desired response of the machine. Proper usage of all controls; booms, dipper stick, bucket, stabilizers, swing, is mandatory.

PERFORMANCE CHECK: The instructor assigns the operation to the student. Knowledge of the controls is checked with a written pictorial identification or oral exam. The student is placed in an operating situation and given specific commands or hand signals.

RESOURCES: Operator's Manual

3.7.2 Aligning Backhoe

OBJECTIVE:	Given a backhoe and a set of stakes to follow, the student must align the tractor and backhoe with the stakes and move the tractor as necessary, keeping it aligned to within ± 3 inches either side of the center line the line to be dug.
EQUIPMENT:	- tractor and backhoe - prescribed center line
SPECIAL PREPARATION:	Supply the necessary layout of stakes for the student to follow.
STUDENT ACTION:	The student learns to position the tractor and backhoe over the center line of the trench to be dug. Measurement of the specifications should be made at the pivot point of the boom swing (the point where the backhoe boom is attached to the tractor). When the pivot point of the backhoe is over the center line of the trench, the trench will remain straight.
PERFORMANCE CHECK:	The instructor observes the student performance. Check is made for alignement according to the specifications. Where necessary, explain errors or weaknesses to the student. Allow time for practice, give helpful suggestions, and re-test.

3.7.3 Digging Trench

OBJECTIVE:	Given a backhoe and a set of stakes to follow, the student must dig a trench to a specified depth within ± 2 inches.
EQUIPMENT:	- backhoe - transit, level, or hand level - target rod
SPECIAL PREPARATION:	Provide the necessary specifications for the student to follow.
STUDENT ACTION:	The student digs the trench to the given specifications. The skill of 3.7.2 is used in aligning the backhoe over the trench to maintain straightness.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student meets the specifications. Check is made with an instrument to determine the elevations and uniformity of the cut.
RESOURCES:	See 6.3.2 and 6.3.4

3.7.4 Digging A Pit

OBJECTIVE:	Given a backhoe and a set of specifications for a pit, the student must dig a pit to within ± 3 inches of the specifications.
EQUIPMENT:	- backhoe - transit, level or hand level - target rod
SPECIAL PREPARATION:	Provide a set of specifications for the student to follow.
STUDENT ACTION:	The student learns to position the backhoe and dig a pit to the necessary specification. For small pits, the edge may be dug, then the center. For larger pits, one end and sides may be dug as the backhoe is moved. It is possible to dig the last end from the side for squareness. The student should learn to plan the positioning of the backhoe ahead of the actual digging.
PERFORMANCE CHECK:	The instructor observes the student's performance in relation to the specifications. Measurement is made and compare to the specifications. Student weaknesses should be noted and further work assigned to assist the learning of the skill.
NOTE:	The specifications can be less exact for some jobs.

3.8.0 Grader

Learning controls of a grader 3.8.1

Grading a road or lot 3.8.2

Grading a ditch 3.8.3

Scarifying a surface 3.8.4

3.8.I Learning Controls Of A Grader

OBJECTIVE:	Given a road grader, the student must know the controls for operation of the machine to 100% accuracy.
EQUIPMENT:	- a grader - operator's manual
STUDENT ACTION:	The student learns the function and operation of each lever or control. The student learns which direction to move a lever to produce the desired response of the machine. Foot pedals, transmission controls, blade controls, scarifier, and front wheel tilt are learned.
PERFORMANCE CHECK:	The instructor checks the student's knowledge of the controls with a written pictorial identification exam. Assign operation to the student by vocal command or hand signal. Check the student's response in relation to the specifications. Observe the student's procedure and note weaknesses and errors. Explain the errors. Allow time for review and practice. Re-assign task and re-test.

3.8.1

3.8.2 Grading A Road Or Lot

OBJECTIVE:	Given a grader and a set of specifications for a road or lot, the student must grade the road or lot to the specifications within + 0.2 ft.
EQUIPMENT:	- grader - transit or level - target rod
SPECIAL PREPARATION:	Provide a set of specifications for the student to follow.
STUDENT ACTION:	The student learns to control the grader blade to meet the specifications. He learns to carry enough dirt to fill low spots. On the next path, the student laps the first path enough to make a smooth surface from one pass to the next.
PERFORMANCE CHECK:	The instructor observes the student's performance in relation to the specifications. The student's work is measured and compared to the specifications. Helpful pointers are given in weak areas. The task is re-assigned and retested after further practice.
NOTE:	Most specifications require the surface to be left 0.1 ft. over the finish grade.

3.8.3 Grading A Ditch

OBJECTIVE:	Given a grader and a set of specifications for a ditch, the student must cut a ditch to the specifications.
EQUIPMENT:	- grader - transit or level
SPECIAL PREPARATION:	Provide a set of specifications for the student to follow.
STUDENT ACTION:	The student learns to cut a ditch. The initial cuts (2 or 3) are made, then the dirt is spread. After the fourth and possible fifth cuts are made, the bank is sloped. Then the ditch is cleaned and the dirt spread. The student learns the many combinations of blade placement. Also front wheel positioning is important.
PERFORMANCE CHECK:	The instructor observes the student's performance in relation to the specifications. The ditch is measured and compared to the specifications. Helpful pointers are given in areas of weakness. The student corrects any errors in the ditch.
RESOURCES:	Caterpillar Operator's Manuals for graders

3.8.4 Scarifying A Surface

OBJECTIVE:	Given a grader and a hard surface to scarify, the student must scarify the surface to the instructor's satisfaction.
EQUIPMENT:	- a grader with a scarifier
STUDENT ACTION:	The student learns to scarify a hard surface. Skill is learned in proper positioning of the grader for successive passes. Most scarifiers are narrower than the grader and skips can easily occur.
PERFORMANCE CHECK:	The instructor observes the student's perform to determine if the student is correctly scarifying the surface. Check is made for proper depth, uniformity of depth, and the lack of skips.

3.9.0 Scraper

Learning controls of scraper 3.9.1

Cutting to grade 3.9.2

Filling to grade 3.9.3

3.9.1 Learning Controls Of Scraper

OBJECTIVE: Given a scraper, the student must know the controls for operation of the machine to 100 % accuracy.

EQUIPMENT:
- the operator's manual
- a scraper

STUDENT ACTION: The student learns the function and operation of each lever or control. The student learns which direction to move a lever to produce the desired response of the machine. Foot pedals, transmission controls, pan, apron, and elevator are learned.

PERFORMANCE CHECK: The instructor checks the student's knowledge of the control with a written pictorial identification exam. He then assigns an operation to the student by vocal command or hand signal. The student's response is checked by observation. Where necessary, the student's weaknesses are noted and helpful suggestions are made.

RESOURCES: Operator's Manual for the specific machine

3.9.1

3.9.2 Cutting To Grade

OBJECTIVE:	Given a scraper and a set of specifications, the student must cut away dirt to specifications.
EQUIPMENT:	- scraper - transit or level - target rod
STUDENT ACTION:	The student learns to control the pan height and make a cut to the specified depth. When the cut is done or the pan full, the apron is lowered and the pan raised. The dirt is transported to a specified place.
PERFORMANCE CHECK:	The instructor observes the student's performance in relation to the specifications. The cut is measured and compared to the specifications. Any errors are corrected by the student to make the cut accurate.
NOTE:	Most specifications require the cut to be left 0.5 ft. over the finish grade. Closer cuts are made with a grader, the dirt is windrowed, then picked up with the scraper.

3.9.3 Filling To Grade

OBJECTIVE: Given a scraper and a set of specifications, the student must fill to the specifications.

EQUIPMENT:

- scraper
- transit or level
- target rod

STUDENT ACTION: The student learns to control the pan height and make a fill to the specified level. The pan height is set before the apron is opened. After opening the apron, the tail gate is brought forward to keep a steady flow of dirt over the front edge of the pan.

PERFORMANCE CHECK: The instructor observes the student's performance. Check is made for proper technique in setting the height of the pan and use of the tail gate. Helpful suggestions are given in the areas of weakness and further practice time is given before retesting.

3.9.3

NOTE: Most fills are made and compacted to at least 0.5 ft. over the finish grade. Then cut down with grader (see NOTE 3.9.2).

3.10.0 Pulled Attachments

Pulling Attachments 3.10.1

3.10.1 Pulling Attachments

OBJECTIVE:	Given a tractor and a pulled attachment such as a sheepsfoot roller or disc-harrow, the student must pull the attachment, performing the specified job without skipping, and using care when turning.
EQUIPMENT:	- a pulled attachment - a tractor
STUDENT ACTION:	The student learns to pull the attachment and perform the specified job. Care is exercised in working the ground the proper number of times to get the desired results. The student learns to turn and watch that the attachment does not catch on the tractor track or tire.
PERFORMANCE CHECK:	The instructor observes the student action in relation to the objective. Any student weaknesses are noted and helpful suggestions are made.

BIBLIOGRAPHY

Construction Equipment Guide, David a Day, John Wiley and Sons, New York.

Construction Equipment Operation (Programmed text), Department of Nonresident Instruction, U.S. Army Engineer School, Fort Belvoir, Virginia 22060.

Heavy Construction Course, Universal Heavy Construction Schools, 1901 N.W. 7th Street, Miami, Florida 33125.

Operating Engineers Training, National Schools of Construction, Inc., 10852 W. Wisconsin Avenue-Drawer 192, Milwaukee, Wisconsin.

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    - 4.6.5 Backing Into Dock - Left Side of Truck
    - 4.6.6 Backing Into Dock - Right Side of Truck
    - 4.6.7 Jack-knife Docking of Tractor-Trailer
  - 4.7.0 Maneuvering
    - 4.7.1 Left-Hand Turn
    - 4.7.2 Right-Hand Turn
    - 4.7.3 "U" Turn
    - 4.7.4 Through 10-feet Opening
  - 4.8.0 Parking
    - 4.8.1 Parking of Truck
    - 4.8.2 Parallel Parking of Truck
  - 4.9.0 Loading & Securing Load
    - 4.9.1 Positioning Load
    - 4.9.2 Chaining and Booming Load
    - 4.9.3 Dumping Load
  - 4.10.0 Over-The-Road
    - 4.10.1 Mapping the Route
    - 4.10.2 Transporting a Load

4.I.0 REGULATIONS AND INSPECTIONS

Instructional Permit - State of Illinois, Class "D" Driver's License 4.I.I

Regulations - State of Illinois, Second Division Vehicles 4.I.2

Class "D" Driver's License 4.I.3

Federal Safety Regulations 4.I.4

Log Book, Completion of 4.I.5

General Inspection 4.I.6

4.1.1 Instructional Permit - State of Illinois, Class "D" Driver's License

OBJECTIVE:	Given the necessary information, the student knows and understands the state regulations for truck driving and satisfactorily passes the written test for State of Illinois Class "D" Driver's License.
EQUIPMENT:	Rules of the Road
STUDENT ACTION:	Student learns the necessary information from the Rules of the Road and takes the written test.
PERFORMANCE CHECK:	Written test for State of Illinois Class "D" Driver's License given by the Driver's License Examiner.
RESOURCES:	Rules of the Road, Michael J. Howlett, Secretary of State, State of Illinois, Springfield, Illinois. * Your Driver's Exam and Road Test, Benjamin C. Bogue, The National School of Safe Driving, Inc., Chicago, Illinois 60639
*NOTE:	Make certain the Rules of the Road is the latest Edition.

4.1.2 Regulations - State of Illinois, Second Division Vehicles

OBJECTIVE:	Given the necessary information, the student knows and understands the laws governing weight limitations, vehicle regulation classifications, and permits according to the instructor's satisfaction.
EQUIPMENT:	- license plate application (vehicle registration) - over-weight permit applications
STUDENT ACTION:	The student learns the weight allowed on a single axle tandem axle, and various combinations of axles. He is aware of the necessary vehicle registration classification for axle combinations, and is acquainted with procedure for securing permits for over-weight and over-size. He learns where to obtain information on clearance of structures and load limits on bridges.
PERFORMANCE CHECK:	Determine if student has acquired the material of the "student action" by a written or oral test over the facts involved.
RESOURCES:	Oversize and Overweight Permit Movements on State Highways, Department of Transportation, 2300 South Dirksen Parkway, Springfield, Illinois 62764 Vertical and Horizontal Clearances of Structures & Load Limit Roads and Bridges, Department of Transportation, 2300 South Dirksen Parkway, Springfield, Illinois 62764 Vehicle Sizes and Weights Manual, J.J. Keller & Associates, 145 West Wisconsin Avenue, Neenah, Wisconsin 54956
NOTE:	Local newspapers may be a source for a levee of fines for overweight loads. Use Local State Police as resource person.

4.1.3 Class "D" Driver's License

OBJECTIVE: After sufficient driving experience with an instructor, the student secures a State of Illinois Class "D" Driver's License according to the state specifications.

EQUIPMENT:

- truck and trailer

STUDENT ACTION: The student takes the driving test for the State of Illinois Class "D" Driver's License with a driver's license examiner.

PERFORMANCE CHECK: Assess the performance with the driving test given by the driver's license examiner. If student fails, isolate the area of weakness and offer constructive help.

NOTE: A minimum of 10 hours of over-the-road experience is suggested before testing.

4.1.4 Federal Safety Regulations

OBJECTIVE: Given the required information, the student knows and understands the Federal Safety Regulations, Parts 391 - 397, and demonstrates that knowledge with at least 70% score on the American Trucking Association Test.

EQUIPMENT: Test, American Trucking Association, ATA form C0690

STUDENT ACTION: The student learns the definitions and regulations necessary for a satisfactory working knowledge of the Federal Safety Regulations. Study is made of Parts 391 through 397.

PERFORMANCE CHECK: Test the student with the Written Examination, ATA form C0690. If test is failed, isolate the weakness and retest after necessary remedial help.

RESOURCES: Truck Driver Training, "A Manual for Driver-Trainers", American Trucking Associations, Inc., Washington, D.C. pp. 15-30.

Driver Handbook for Private Motor Carriers, American Trucking Associations, Inc., Washington, D.C.

4.1.5 Log Book, Completion of

OBJECTIVE:	Given the necessary forms, the student fills out a log of daily driving to the instructor's satisfaction.
EQUIPMENT:	Driver's Daily Log (form MCS 59) Motor Carrier Safety Regulations, Part 395
STUDENT ACTION:	The student must fill out a daily log using the necessary definitions and regulations from 4.1.4. Care is given to accuracy and neatness.
PERFORMANCE CHECK:	Assign a log to be completed and determine if the student correctly completed the log book. It is suggested that a student correctly complete at least three (3) daily logs for the performance check.
RESOURCE:	Motor Carrier Safety Regulations; U.S. Department of Transportation, Federal Highway Administration, Bureau of Motor Carrier Safety, Washington, D.C. Pellegrino, Charles, Owner Operator, "Your Logbook"; Nov./Dec., 1973. Driver's Daily Log - Form MCS 59.
NOTE:	All necessary information must be given and all figures should total correctly.

4.1.6 General Inspection

OBJECTIVE:	Given a truck, the student makes a general inspection of the truck to determine its condition and readiness according to the Motor Carrier Safety Regulations.
EQUIPMENT:	- Truck or Combination - Driver's Inspection Report (ATA Form C0830)
STUDENT ACTION:	The student learns to check the condition of the truck before operating it. Any inadequacies or malfunctions should receive repair before operating the truck.
PERFORMANCE CHECK:	The condition of the truck must be observed to determine if the student has properly checked the condition of the truck. This performance check should be done at least three times for the student to demonstrate his competency
RESOURCES:	Check-list on Official Driver's Daily Log Form MCS 59. Motor Carrier Safety Regulations, Part 396. Driver's Inspection Report, American Trucking Association, Inc., A.T.A. Form C0830.

4.2.0 SHIFTING

4-speed transmission 4.2.1

5-speed transmission 4.2.2

Transmission with 2-speed axle 4.2.3

5-speed transmission w/3-speed auxiliary 4.2.4

10-speed roadranger 4.2.5

13-speed roadranger 4.2.6

4.2.1 4-speed Transmission

OBJECTIVE: Given a truck with a four-speed transmission, the student shifts the transmission without jerking or grating, and maintains the proper engine R.P.M. range to the instructor's satisfaction.

EQUIPMENT:

- truck equipped with a 4-speed transmission

STUDENT ACTION: The student learns to upshift and downshift the transmission. Double-clutching is taught for the downshift. Care is exercised that the student does not lug or over-speed the engine.

PERFORMANCE CHECK: Through observation, determine if the student is correctly shifting transmission. Where necessary, provide suggestions for correcting the shifting procedure.

RESOURCES: The operator's manual for the specific truck being used.

Truck Driver Training, "A Manual for Driver-Trainers", American Trucking Association, Inc., Washington, D.C., pages 40,41.

4.2.2. 5-speed Transmission

OBJECTIVE: Given a truck with a five-speed transmission, the student shifts the transmission without jerking or grating, and maintains the proper engine R.P.M. range to the instructor's satisfaction.

EQUIPMENT:

- truck equipped with a 5-speed transmission

STUDENT ACTION: The student learns to upshift and downshift the transmission. Double-clutching is taught specifically for the downshift.

PERFORMANCE CHECK: Observation is made to determine if the student is correctly shifting the transmission. Where necessary, provide suggestions for correcting the shifting procedure.

RESOURCES: The operator's manual for the specific truck being used.

Truck Driver Training, "A Manual for Driver-Trainers", American Trucking Associations, Inc., Washington, D.C., pages 40,41.

CAUTION: Care is exercised that the student does not lug or over speed the engine. (For example - Maxidynes should be kept between 1300 and 2100 R.P.M.'s.

4.2.3 Transmission With 2-Speed Axle

OBJECTIVE: Given a truck with a 2-speed axle, the student shifts the transmission and axle without jerking or grating, and maintains the proper R.P.M. range and proper sequence to the instructor's satisfaction.

EQUIPMENT:

- a truck equipped with a 2-speed axle.

STUDENT ACTION: The student learns to upshift and downshift the 2-speed axle.

Upshift - The axle is upshifted by moving the shift button to "high", then releasing the accelerator until the axle shifts.

Downshift - The axle button is moved to "low" and the clutch disengaged at the same time. The accelerator is held down during the shift.

Split-shifting - The axle is used in each transmission gear to give additional power and reduce lugging. When upshifting the transmission and downshifting the axle, the transmission is shifted first, then the axle is shifted just before the clutch is engaged. When downshifting the transmission and upshifting the axle, the axle is shifted, accelerator released, then the transmission is downshifted.

PERFORMANCE CHECK: Observation of the student is made to determine if he is correctly shifting the transmission and axle. Make certain the sequence is correct, and that the axle does not "grind" during clutch disengagement. Where necessary, provide suggestions for correcting the shifting pattern and techniques.

RESOURCES: Manufacturer's instructions for shifting 2-speed axle.

NOTE: Complete clutch pedal travel is not necessary for 2-speed axle shifts. Approximately half depression of the pedal is sufficient and smoothness is greatly increased.

4.2.4

4.2.4 5-speed Transmission w/3-speed Auxiliary

OBJECTIVE: Given a truck with a 5-speed transmission and 3-speed auxiliary, the student shifts both transmissions without jerking or grating and maintains the proper R.P.M. range and proper gear sequence.

EQUIPMENT:

- truck equipped with a 5-speed transmission and a 3-speed auxiliary.

STUDENT ACTION: The student learns to upshift and downshift the transmissions Proper sequence is taught. The main transmission is shifted with the auxiliary in high gear. Both transmissions should not be in neutral at the same time.

Upshifting - When the auxiliary transmission is in high, the main transmission is shifted into the next gear. Then the auxiliary is downshifted to first. Engine R.P.M.'s are allowed to drop when shifting the main transmission, then raised when the auxiliary is downshifted.

Downshifting - When the auxiliary transmission is in first and downshift is necessary, shift the auxiliary to high, then downshift the main transmission.

PERFORMANCE CHECK: Observation of the student is made to determine if he is correctly shifting the transmissions. Make certain that the sequence is correct. Where necessary, provide suggestions for correcting the shifting patterns and techniques.

RESOURCES: The Operator's Manual for the specific truck being used.

CAUTION: Care is exercised that the student does not lug or overspeed the engine.

4.2.5 10-speed Roadranger

OBJECTIVE:	Given a truck with a 10-speed Roadranger, the student shifts the transmission without jerking or grating and maintains the proper engine R.P.M. range and proper gear sequence.
EQUIPMENT:	- truck equipped with a 10-speed Roadranger (Fuller)
STUDENT ACTION:	The student learns to upshift and downshift the transmission.
PERFORMANCE CHECK:	Observation of the student is made to determine if he is correctly shifting the transmission. Where necessary, provide suggestions for correcting shifting procedure.
RESOURCES:	The operator's manual for the specific truck being used.
CAUTION:	Care is exercised that the student does not lug or overspeed the engine.

4.2.6 13-speed Roadranger

OBJECTIVE:	Given a truck with a 13-speed Roadranger, the student shifts the transmission without jerking or grating and maintains the proper engine R.P.M. range and proper gear sequence.
EQUIPMENT:	- truck equipped with a 13-speed Roadranger
STUDENT ACTION:	The student learns to upshift and downshift the transmission. Proper sequence is taught. (See appendix).
PERFORMANCE CHECK:	Observation of the student is made to determine if he is correctly shifting the transmission. Where necessary, provide suggestions for correcting the shifting pattern and technique.
RESOURCES:	The operator's manual for the specific truck being used.
CAUTION:	Care is exercised that the student does not lug or overspeed the engine.

4.3.0 BACKING & DOCKING

Backing into alley - aligned 4.3.1

Backing into alley - left side of truck 4.3.2

Backing into alley - right side of truck 4.3.3

Backing into dock - straight back 4.3.4

Backing into dock - left side of truck 4.3.5

Backing into dock - right side of truck 4.3.6

4.3.1 Backing Into Alley - Truck Aligned

OBJECTIVE:	Given a truck the student must maneuver straight back into and/or through an alley.
EQUIPMENT:	- safety cones - straight truck
STUDENT ACTION:	The student aligns the truck with the alley and backs straight into the alley using the mirrors. The backing distance should be at least twice the length of the truck, keeping the truck straight.
PERFORMANCE CHECK:	The student learns to pull in front of an alley and align the truck while pulling forward: then to back into and possibly through the alley. The student's performance must be observed to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness continue the task until the student can competently perform the task.
NOTE:	Suggested alley width, 9-ft.

4.3.2 Backing Into Alley - Left Side of Truck

OBJECTIVE:	Given a truck the student must back into the alley from an angular position with the alley off the left side of the truck.
EQUIPMENT:	- safety cones - straight truck
STUDENT ACTION:	Using the mirrors, the student must back the truck into an alley where conditions are such that he cannot align the truck with the alley. In this exercise the approach should put the alley on the driver's side of the truck. The student has to align the truck with the alley as the truck enters the alley.
PERFORMANCE CHECK:	The student's performance is observed to determine if he meets the objective. The task should be performed at least twice for the performance check.
NOTE:	Suggested alley width, 9 ft.

4.3.3 Backing Into Alley - Right Side of Truck

OBJECTIVE:	Given a truck, the student must back into the alley from an angular position with the alley on the right side of the truck.
EQUIPMENT:	- safety cones - straight truck
STUDENT ACTION:	Using the mirrors, the student must back the truck into an alley where conditions do not allow the truck to be aligned with the alley. In this exercise, the approach puts the alley on the right side of the truck, one of the most difficult maneuvering conditions because of the poor visibility. The student has to align the truck with the alley as the truck enters the alley.
PERFORMANCE CHECK:	Observe the student's performance to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.
NOTE:	Suggested alley width, 9 ft.

4.3.4 Backing Into A Dock - Straight Back

OBJECTIVE: Given a truck the student must align the truck with the dock, back the truck to within 6 inches of the dock (measured at the center of the truck) and center within + 6 inches.

EQUIPMENT:
- a docking area
- straight truck

STUDENT ACTION: The student must back the truck to the dock from a position aligned with the dock. The student learns to pull in front of the dock and align truck before starting to back. The truck should be positioned so the dock is visible in both mirrors.

PERFORMANCE CHECK: Observe the student's performance to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

4.3.5 Backing Into Dock - Left Side Of Truck

OBJECTIVE: Given a dock and a truck positioned so the dock is in an angular position on the left side of the truck, the student must back the truck to within 6 inches of the dock (measured at the center of the truck) and center within + 6 inches.

EQUIPMENT:

- straight truck
- docking area

STUDENT ACTION: The student must position the truck in front of the dock at an angle. The dock should be on the left side of the truck. The student then backs the truck to the dock within the specifications, using the mirrors. Left side is used whenever possible for better visibility in backing.

PERFORMANCE CHECK: Observe the student's performance to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

4.3.6 Backing Into Dock - Right Side of Truck

OBJECTIVE: Given a dock and a truck positioned so the dock is in an angular position on the right side of the truck, the student must back the truck to within 6 inches of the dock (measured at the center of the truck) and center within +6 inches.

EQUIPMENT:

- straight truck
- docking area

STUDENT ACTION: The student must position the truck in front of the dock at an angle. The dock should be on the right side of the truck. The student backs the truck to the dock within the specifications, using the mirrors. The right side causes maximum difficulty in visibility.

PERFORMANCE CHECK: Observe the student's performance to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

CAUTION: Student must exercise extreme caution because of poor visibility when backing to the right.

4.4.0 MANEUVERING

Left - hand turn 4.4.1

Right - hand turn 4.4.2

"U" turn 4.4.3

Through 10-feet opening 4.4.4

4.4.1 Left - Hand Turn

OBJECTIVE:	Given a truck, the student must maneuver a left hand turn at an intersection keeping the truck to the right of the center line throughout the turn.
EQUIPMENT:	- single truck
STUDENT ACTION:	The student must make the left-hand turn by keeping the truck far enough to the right to stay right of the center lines. (The turn should be completed with the truck in the lane closest to center.)
PERFORMANCE CHECK:	Observe the student's performance to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.
NOTE:	The intersection may be simulated with safety cones for a practice course.

4.4.2 Right - Hand Turn

OBJECTIVE:	Given a truck, the student must maneuver a right-hand turn at an intersection keeping the truck off of the curb and out of on-coming traffic where possible.
EQUIPMENT:	- single truck
STUDENT ACTION:	The student must maneuver a right-hand turn by keeping the truck to the left an amount sufficient to keep the truck off the curb. The student is allowed to use a portion of the other lanes where necessary to complete the turn (Care is used when the truck enters on-coming lanes of traffic.)
PERFORMANCE CHECK:	Observe the student's performance to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.
CAUTION:	Extreme caution is used when the truck must enter on-coming lanes of traffic to complete the turn. Also, watch for cars which might squeeze between the truck and curb while the truck is waiting to make the turn.

4.4.3 "U" Turn

OBJECTIVE:	Given a truck, the student turns the truck around in an area whose width is twice the length of the truck.
EQUIPMENT:	- straight truck
STUDENT ACTION:	The student must turn the truck around in an area whose width is twice the length of the truck and go back in the direction from which he came.
PERFORMANCE CHECK:	Observe the student's performance to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

4.4.4 10 - Feet Opening (Single Truck)

OBJECTIVE:	Given a truck the student must maneuver the truck through a 10-ft. width.
EQUIPMENT:	- straight truck
STUDENT ACTION:	The student must drive the truck through a 10-feed wide opening without touching either side.
PERFORMANCE CHECK:	Observe the student's performance to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

4.5.0 HOOKING TO TRAILER

Alignment of tractor with trailer 4.5.1

Adjustment of dollies 4.5.2

Catching kingpin with fifth wheel 4.5.3

Hook-up of air lines 4.5.4

Unhooking of trailer 4.5.5

4.5.I Alignment of Tractor With Trailer

OBJECTIVE: Given a truck-tractor and semi-trailer the student must align the tractor to the trailer within +4 inches in three attempts.

EQUIPMENT:

- truck-tractor
- semi-trailer

STUDENT ACTION: Student must align the tractor with the trailer while backing to the trailer. The student must stop before reaching the trailer and check the height of the trailer in relation to the fifth wheel (see 4.5.2). The +4-inches tolerance allows the king pin to be caught by the fifth wheel. No more than 4-inches keeps the side strain on the dollies to a minimum.

PERFORMANCE CHECK: The student's performance is observed to determine if the student aligned the fifth wheel and king pin to the specifications. The performance should be checked at least twice to insure proper results. If necessary, have student continue the task until he is able to meet the specifications. Offer suggestions to help with areas of weakness.

RESOURCES: Truck Driver Training, "A Manual for Driver-Trainers", American Trucking Associations, Inc., Washington, D.C. 20036, page 45.

NOTE: The student must learn to use mirrors when backing to the trailer. This exercise builds on the skills of 4.3.I.

4.5.2 Adjustment of Dollies

OBJECTIVE:	Given the conditions of 4.5.1 the student must adjust the dollies to bring the trailer within the specifications of level with the fifth wheel to 3-inches below. (If dollies are not adjustable, provisions must be made to get the trailer level with or below the fifth wheel.)
EQUIPMENT:	- truck tractor - semi-trailer
STUDENT ACTION:	The student must adjust the height of the trailer so the trailer is even with the fifth wheel to no more than 3-inches below the fifth wheel. Moderate resistance should be felt when the fifth wheel tips forward as the truck backs under the trailer.
PERFORMANCE CHECK:	The student's performance is observed to determine if the student has set the trailer even with or within 3-inches below a line even with the center of the fifth wheel. If not, have the student correct the position of the trailer dollies. Continue the task until he can set them at the correct height.
RESOURCES:	Truck Driver Training, "A Manual for Driver-Trainers", American Trucking Associations, Inc., Washington, D.C. 20036, page 45.
NOTE:	The trailer should be low enough that firm contact is made between the fifth wheel and upper plate on the trailer.

4.5.3 Catching the Kingpin with the Fifth Wheel

OBJECTIVE:	Given the conditions of 4.5.2 the student must back the truck-tractor under the semi-trailer and catch the kingpin with the fifth wheel.
EQUIPMENT:	- truck-tractor - semi-trailer
STUDENT ACTION:	The student must back the tractor under the trailer until the fifth wheel catches. Student pulls forward easily to make certain that fifth wheel is securely latched. Care is exercised to be certain that the trailer is secure. Damage to air lines, electrical equipment, truck, trailer, and load can result. After a visual inspection is made to insure that the fifth wheel is locked, the landing gear (dollies) should be raised.
PERFORMANCE CHECK:	The student's performance is observed to determine if the student securely catches the kingpin with the fifth wheel.
RESOURCES:	Truck Driver Training, "A Manual for Driver-Trainers", American Trucking Associations, Inc., Washington, D.C. 20036, page 45.
NOTE:	Make certain the jaws of the fifth wheel are fully open.
CAUTION:	Make certain the fifth wheel is latched before attempting driving off.

4.5.4 Hook-up of Air Lines

OBJECTIVE: Given the conditions of 4.5.3, *the student must attach air lines and electrical connector and checks the function of the brakes and lights.

EQUIPMENT:

- truck-tractor
- semi-trailer

STUDENT ACTION: The student must properly attach the air hoses (emergency and service) to the trailer. Check is made to determine if hoses are attached properly. Student should be trained to listen for the sound of the brakes releasing once the service tanks are charged with air. Electrical connection must be made and lights must be checked for proper functioning.

The trailer brakes are actuated by the emergency braking control valve located on the dash. It must be in the "normal" position to charge the trailer brakes. The tractor hose which discharges air when the valve is in "normal" position is usually hooked to the left connector on the trailer.

PERFORMANCE CHECK: The student's performance is observed to determine if the student has properly attached the air lines and electrical connections. Check is made to see if they function correctly. If not, review the task and re-teach the indicators of correctly attached lines. Assign the task again.

RESOURCES: Truck Driver Training "A Manual for Driver-Trainers", American Trucking Associations, Inc., Washington, D.C. 20036, page 45.

***NOTE:** Some authorities suggest that the air hook ups are made before the tractor is backed under the trailer (This would put 4.5.4 between 4.5.2 and 4.5.3.) Such a technique prevents the trailer from rolling during hookup.

4.5.5 Unhooking of Trailer

OBJECTIVE: Given a truck-tractor and semi-trailer, the student must secure the trailer and unhook from it to the instructor's satisfaction.

EQUIPMENT:

- truck-tractor
- semi-trailer

STUDENT ACTION: The student parks the trailer in a suitable place, blocks the wheels when necessary, and prepares to unhook. The dollies are lowered until they are supporting most of the weight of the trailer (where necessary, planks are used under the dollies to prevent sinking). The fifth wheel is released, and the air and electrical connections unhooked. (The air brakes control valve is set on "Emergency".) The tractor is eased forward from underneath the trailer.

PERFORMANCE CHECK: The student's performance is observed to determine if the student has properly located, supported and unhooked the trailer. Make certain that planks are placed under the dollies where necessary. The ends of the air hoses and electrical conductor should be securely fastened to the tractor.

RESOURCES: Truck Driver Training "A Manual for Driver-Trainers", American Trucking Associations, Inc., Washington, D.C. 20036, page 45.

CAUTION: The weight of the trailer should be gradually transfered from the fifth wheel to the trailer dollies by pulling forward slowly.

4.6.0 Backing & Docking Truck-Tractor & Semi-Trailer

Backing into alley - aligned 4.6.1

Backing into alley - left side of truck 4.6.2

Backing into alley - right side of truck 4.6.3

Backing into a dock - straight back 4.6.4

Backing into dock - left side of truck 4.6.5

Backing into dock - right side of truck 4.6.6

Jack-knife docking of tractor-trailer 4.6.7

4.6.1 Backing Into Alley Truck Aligned

OBJECTIVE: Given a truck-tractor and semi-trailer combination, the student must maneuver straight back into an alley to the instructor's satisfaction.

EQUIPMENT:

- truck-trailer
- semi-trailer
- safety cones

STUDENT ACTION: The student must align the truck with the alley and back straight into the alley using the mirrors. The backing distance should be at least twice the length of the truck-trailer combination and it should be kept straight during the backing. The student learns to pull in front of an alley and align the truck while pulling forward: then to back into and possibly through the alley.

PERFORMANCE CHECK: Observe the student's performance to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, continue the task until the student can competently perform the task.

NOTE: Suggested alley width, 10-ft.

4.6.2 Backing Into Alley - Left Side of Truck

OBJECTIVE: Given a truck-tractor and semi-trailer combination the student must back into an alley from an angular position with the alley off the left side of the truck.

EQUIPMENT:

- truck-tractor
- semi-trailer
- safety cones

STUDENT ACTION: Using the mirrors, the student must back the trailer into an alley where conditions are such that he cannot align the truck-trailer combination with the alley. In this exercise the approach should put the alley on the driver's side of the truck. The student has to align the trailer with the alley as the trailer enters the alley.

PERFORMANCE CHECK: The student's performance is observed to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine the cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

NOTE: Suggested alley width, 10-ft.

4.6.3 Backing Into Alley - Right Side of Truck

OBJECTIVE: Given a truck-tractor and semi-trailer combination the student must back into the alley from an angular position with the alley on the right side of the truck.

EQUIPMENT:

- truck-tractor
- semi-trailer
- safety cones

STUDENT ACTION: Using the mirrors, the student must back the trailer into an alley where conditions do not allow the truck-tractor combination to be aligned with the alley. In this exercise the approach puts the alley on the right side of the truck, one of the most difficult maneuvering conditions because of the poor visibility. The student has to align the trailer with the alley as the trailer enters the alley.

PERFORMANCE CHECK: The student's performance is observed to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine the cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

NOTE: Suggested alley width, 10-ft.

4.6.4 Backing Into A Dock - Straight Back

OBJECTIVE: Given a truck-tractor and semi-trailer combination the student must align the truck with the dock and back the trailer within 6 inches of the dock (measured at the center of the truck) and centered within ±6 inches.

EQUIPMENT:

- truck-tractor
- semi-trailer
- docking area

STUDENT ACTION: The student must back the tractor-trailer to the dock from a position aligned with the dock. Student learns to pull in front of the dock and align the truck with the dock before starting to back. The truck should be positioned so the dock is visible in both mirrors.

PERFORMANCE CHECK: The student's performance is observed to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine the cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

4.6.5 Backing Into Dock - Left Side of Truck

OBJECTIVE: Given a dock and a truck-tractor semi-trailer combination positioned so the dock is in an angular position on the left side of the combination, the student must back the truck to within 6 inches of the dock (measured at the center of the trailer) and centered within ±6 inches.

EQUIPMENT:

- truck-tractor
- semi-trailer
- docking area

STUDENT ACTION: The student must position the combination in front of the dock at an angle. The dock should be on the left side of the truck. The student then backs the trailer to the dock within the specifications of the objective. Left side is used whenever possible for better visibility in backing.

PERFORMANCE CHECK: The student's performance is observed to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine the cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

4.6.6 Backing Into Dock - Right Side Of Truck

OBJECTIVE: Given a dock and a truck-tractor semi-trailer combination positioned so the dock is in an angular position on the right side of the combination, the student must back the truck to within 6 inches of the dock (measured at the center of the trailer) and centered within ±6 inches.

EQUIPMENT:

- truck-tractor
- semi-trailer
- docking area

STUDENT ACTION: The student must position the combination in front of the dock at an angle. The dock should be the right side of the truck. The student must back the trailer to the dock within the specifications of the objective. The right side causes maximum difficulty in visibility.

PERFORMANCE CHECK: The student's performance is observed to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine the cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

CATUION: Student must exercise extreme caution because of poor visibility when backing to the right.

4.6.7 Jack-Knife Docking Of Tractor-Trailer

OBJECTIVE: Given a dock and a truck-tractor and semi-trailer combination the student must park the trailer within 6 inches of the dock (measured at the center of the trailer) with the trailer within ±6 inches of the center of the dock and the tractor at a 90 degree angle to the trailer.

EQUIPMENT:
- truck-tractor
- semi-trailer
- docking area

STUDENT ACTION: The student must park the trailer against the dock and have the tractor at a 90 degree angle. The parking space should be shorter than the length of the combination so the tractor has to be parked at a 90 degree angle to the trailer.

PERFORMANCE CHECK: The student's performance is observed to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine the cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

NOTE: The jack-knifed position is also usable when pulling or winching equipment onto the trailer. The winching can be done over the front of the trailer when the tractor is "jack-knifed".

4.7.0 Maneuvering Truck-Tractor & Semi-Trailer

Left-hand turn 4.7.1

Right-hand turn 4.7.2

"U" turn 4.7.3

Through 10-feet opening 4.7.4

4.7.I Left-Hand Turn — Truck-Tractor & Semi-Trailer

OBJECTIVE: Given a truck tractor and semi-trailer combination, the student must maneuver a left-hand turn at an intersection keeping the trailer to the right of the center line throughout the turn.

EQUIPMENT:
- truck-tractor
- semi-trailer

STUDENT ACTION: The student must make the left-hand turn by keeping the tractor far enough to the right for the trailer to stay left of the center lanes. The turn should be completed with the truck in the lane closest to the center.

PERFORMANCE CHECK: The student's performance is observed to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine the cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

4.7.2 Right-Hand Turn – Truck-Tractor & Semi-Trailer

OBJECTIVE:	Given a truck-tractor and semi-trailer combination, the student must maneuver a right-hand turn at an intersection keeping the trailer off the curb, and out of the on-coming traffic where possible.
EQUIPMENT:	- truck-tractor - semi-trailer
STUDENT ACTION:	The student must maneuver a right-hand turn by keeping the tractor to the left an amount sufficient to keep the trailer off the curb. Student is allowed to use a portion of the other lanes where necessary to complete the turn. (Care is used when the tractor enters on-coming traffic.)
PERFORMANCE CHECK:	The student's performance is observed to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine the cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.
CAUTION:	Extreme caution is used when the truck must enter on-coming lanes of traffic to complete the turn. ALSO, watch for cars which might squeeze between the truck and curb while the truck is waiting to make the turn.

4.7.3 "U" Turn – Truck-Tractor & Semi-Trailer

OBJECTIVE: Given a truck-tractor and semi-trailer combination, the student must turn the truck around in an area whose width is twice the length of the trailer.

EQUIPMENT:

- truck-tractor
- semi-trailer

STUDENT ACTION: The student is required to turn around in an area two times the length of the trailer and go back in the direction from which he came.

PERFORMANCE CHECK: The student's performance is observed to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine the cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

NOTE: Such a turn is not made with loaded equipment unless absolutely necessary, especially on a 3-axle trailer.

4.7.4 10-ft. Opening

OBJECTIVE:	Given a truck-tractor and semi-trailer combination, the student must maneuver the combination through an opening of 10-ft. width.
EQUIPMENT:	- truck-tractor - semi-trailer
STUDENT ACTION:	The student must drive the combination through a 10-feet wide opening without touching either side.
PERFORMANCE CHECK:	The student's performance is observed to determine if he meets the objective. The task should be performed at least twice for the performance check. If there is weakness, determine the cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

4.8.0 Parking

Parking of truck 4.8.l

Parallel parking of truck 4.8.2

4.8.l Parking Of Truck

OBJECTIVE: Given a truck, the student must park the truck so it will remain secure for an indefinite length of time.

EQUIPMENT:

- truck

STUDENT ACTION: The student must park the truck so it will remain secure until moved again. Parking brakes are set and proper chocks are used. The transmission should be in low or reverse, and auxiliary transmission and two speed axles in low range.

PERFORMANCE CHECK: The student's performance is observed to determine if the student has parked the truck according to the specifications. If there is weakness, determine the cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

4.8.2 Parallel Parking Of Truck

OBJECTIVE:	Given a truck, the student must securely park the truck within 6 inches of the curb.
EQUIPMENT:	- truck
STUDENT ACTION:	The student securely parks the truck next to the curb according to the specifications.
PERFORMANCE CHECK:	The student's performance is observed to determine if the student has parked the truck according to the specifications. If there is weakness, determine the cause and offer constructive guides on maneuvering. Have student continue task until he can meet the objective.

4.8.2

4.9.0 Loading & Securing Load

Positioning load 4.9.1

Chaining and booming load 4.9.2

Dumping load 4.9.3

4.9.1 Positioning Of Load

OBJECTIVE: Given a load and a truck, the student must position the load for proper weight distribution to the instructor's satisfaction.

EQUIPMENT:

- truck
- a load

STUDENT ACTION: The student positions the load on the truck. Emphasis is given to positioning the load so that each axle of the truck (or tractor and trailer) has its proper proportion of weight.

PERFORMANCE CHECK: The student's performance is observed to determine if the student has properly positioned the load so the weight is evenly distributed. If not, isolate the cause of error and assign remediation accordingly.

4.9.2 Chaining and Booming Load

OBJECTIVE: Given a condition of 4.9.1, the student chains and booms the load to the truck to the instructor's satisfaction and to Motor Carrier Safety Regulations where applicable.

EQUIPMENT:

- truck-tractor
- semi-trailer
- load
- chains and boomers

STUDENT ACTION: The student fastens the load to the trailer with chains and boomers to hold the load in place and keep it from shifting especially during heavy braking situations.

PERFORMANCE CHECK: The student's performance is observed to determine if the student has met the level of competency. If a weakness is present, isolate it and assign remediation accordingly.

RESOURCES: Motor Carrier Safety Regulations: U.S. Department of Transportation, Federal Highway Administration, Bureau of Motor Carrier Safety.... see part 393.100.

4.9.3 Dumping A Load

OBJECTIVE:	Given a loaded dump truck, the student must dump the load to the instructor's satisfaction.
EQUIPMENT:	- dump truck with a load
STUDENT ACTION:	The student learns the operation of the dump truck. Skill should be gained in two areas, (l) dumping in a pile, and (2) spreading the load. Besides learning to dump a load in a pile, the student is taught to adjust the chains on the tail gate, partially raised bed, and evenly spread the load while driving.
PERFORMANCE CHECK:	The student's performance is observed to determine the level of competency. If weakness is noticed, provide encouragement and instruction in that area and reassign the task.
CAUTION:	Care should be exercised when dumping trucks on a surface that is not level. Tipping can occur, especially if the load does not slide uniformly.

4.10.0 Over-The-Road

Mapping the route 4.10.1

Transporting a load 4.10.2

4.10.0

4.10.1 Mapping The Route

OBJECTIVE:	Given the origin, destination, and subsequent stops of a trip, the student must map the route and estimate the travel time.
EQUIPMENT:	- road map - vertical and horizontal clearances of structures and load limit of roads and bridges.
STUDENT ACTION:	The student must map the route which he intends to travel for the assigned trip. A check should be made of load limits on bridges and roads.
PERFORMANCE CHECK:	Determine if the student mapped the route correctly. If more than one good route is available, the student should be given reason for his choice.
RESOURCES:	Vertical and Horizontal Clearances of Structures and Load Limit Roads and Bridges, Department of Transportation, 2300 South Dirksen , Springfield, Illinois 62764.

4.10.1

4.10.2 Transporting A Load From One Place To Another

OBJECTIVE:	Given the accumulated competencies of the previous tasks, the student must load a truck, secure the load, move the load, dock and unload to the instructor's satisfaction.
EQUIPMENT:	- truck - a load - boomers and chains - docks
STUDENT ACTION:	The student demonstrates the degree to which he has learned the various tasks of truck driving by performing the job outlined above.
PERFORMANCE CHECK:	Observe the student's performance and assess his competency. Determine if the student meets the objective, note any weaknesses which are observed and assign the appropriate task for remediation.
NOTE:	It is suggested that the student cross a set of weigh scales during the trip.

Bibliography

ATA Fleet Safety Service, American Trucking Associations, Inc., 1616 P Street, N.W., Washington, D.C. 20036

Driver's Daily Log Book, Form MCS-59, J. J. Keller and Associates, Inc., 145 West Wisconsin Avenue, Neenah, Wisconsin 54956

Driver Education for Illinois Youth, Federal Project 02-01-05, Office of the Superintendent of Public Instruction, State of Illinois, Springfield, Illinois 62764

Driver Handbook for Private Motor Carriers, American Trucking Associations, Inc., 1616 P Street, N.W., Washington, D.C. 20036

Motor Carrier Safety Regulations, U.S. Department of Transportation, Federal Highway Administration, Bureau of Motor Carrier Safety, Washington, D.C. 20402

Oversize and Overweight Permit Movements on State Highways, State of Illinois, Department of Transportation, 2300 South 31st Street, Springfield, Illinois 62764

Rules of the Road, Secretary of State, State of Illinois, Springfield, Illinois 62764

The Company Rodeo, American Trucking Associations, Inc., 1616 P Street, N.W., Washington, D.C. 20036

The Truck Driver's Handbook, American Trucking Associations, Inc., 1616 P Street, N.W., Washington, D.C. 20036

Truck Driver Training - A Manual for Driver-Trainers, American Trucking Associations, Inc., Washington, D.C. 20036

Trucking Safety Guide, J. J. Keller and Associates, Inc., 145 West Wisconsin Avenue, Neenah, Wisconsin 54956

Vehicle Sizes and Weights Manual, J. J. Keller and Associates, Inc., 145 West Wisconsin Avenue, Neenah, Wisconsin 54956

Verticle and Horizontal Clearance of Structures and Load Limit Roads and Bridges, State of Illinois, Department of Transportation, 2300 South 31st Street, Springfield, Illinois 62764

Your Drivers Exam and Road Test, Benjamin C. Bogue, The National School of Safe Driving, Inc., Chicago, Illinois 60639

DIESEL
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5.1.0 Fuel Systems

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Plugging fuel lines 5.1.2

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5.3.II Measuring Crankshaft

OBJECTIVE:	Given a micrometer and crankshaft, the student must measure the crankshaft to determine the wear and the roundness of the shaft and evaluate the condition of the crankshaft.
EQUIPMENT:	- micrometer - crankshaft
STUDENT ACTION:	The student measures the crankshaft for wear, taper, and roundness, and compares the readings to the manufacturer's specifications. Using the comparison, the student makes evaluation of the crankshaft condition.
PERFORMANCE CHECK:	The instructor determines if the student has correctly measured the crankshaft by observing the technique, and by checking the measurements. Determine if the evaluation made by the student is correctly supported by the evidence.
RESOURCES:	Engines, John Deere, pages 2 - 46, 2 - 53 Diesel, Toboldt, pages 170-172, 247-250

5.3.12 Measuring Camshaft and Bearings

OBJECTIVE: Given a diesel engine in the disassembly process, the student must measure the camshaft and camshaft bearings for wear and compare to the manufacturer's specifications

EQUIPMENT:

- a diesel engine in the overhaul process
- inside and outside micrometer

STUDENT ACTION: The student measures each camshaft (and balance shaft) bearing. He compares the measurement to the manufacturer's specifications and makes evaluations concerning the replacement of bearings. Also, he measures the camshaft for wear. The cam followers are inspected for wear. The instructor measures the camshaft and bearings too.

PERFORMANCE CHECK: Determine if the student properly measured the camshaft and camshaft bearings. The accuracy of the measurement should be within 0.001. The instructor assesses the student's evaluation of whether to replace the camshaft (and balance shaft) and/or bearings.

RESOURCES: Engines, John Deere, pages 2-18, 2-19, 2-20
Diesel, Toboldt, page 269

5.1.3 Removing And Replacing Injectors

OBJECTIVE:	Given a diesel engine with hydraulic or mechanical injectors, the student must remove and replace the injectors to the manufacturer's specifications.
EQUIPMENT:	- diesel engine with hydraulic or mechanical injectors
STUDENT ACTION:	The student removes and replaces the injectors, using care not to damage injection lines or injectors.
PERFORMANCE CHECK:	The student's performance is observed to determine if the student properly removed and replaced the injectors.
RESOURCES:	Engines, John Deere, pages 5-30 Engine Manufacturer's service manual
CAUTION:	Care should be exercised to avoid cross threading of fuel line connections.

5.1.4 Testing Injectors

OBJECTIVE:	Given a hydraulic fuel injector and test equipment, the student must test the injector for cracking pressure and spray pattern according to manufacturer's specifications.
EQUIPMENT:	- set of injectors - injection test equipment
STUDENT ACTION:	The student attaches the injector to the tester, checks connections for leaks, and tests injectors. Instruction is given on the proper use of the injector tester.
PERFORMANCE CHECK:	The student's performance is observed to determine if the student is properly attaching the injector tester, and using proper technique for testing. Check for use of safety goggles and for the keeping of hands clear from the nozzle. Make necessary corrections in technique by emphasizing the importance of accuracy and proper technique.
RESOURCES:	Engines, John Deere, pages 5-31 Engine Manufacturer's service manual
CAUTION:	Keep fingers and hands away from the nozzle tip during testing. Diesel fuel can be injected through the skin during testing, causing poisoning.

5.I.5 Disassembling, Replacing, and Adjusting Nozzles

OBJECTIVE:	Given Bosch or C.A.V. style spray valves the student must disassemble the injector, replace the nozzle, re-assemble the injector, and set the cracking pressure to the manufacturer's specifications.
EQUIPMENT:	- set of injectors - injector tester
STUDENT ACTION:	The student disassembles the injector cleans the parts, and replaces the nozzle. Care is given to cleanliness during the process. The injector cracking pressure is set to the manufacturer's specifications.
PERFORMANCE CHECK:	The student is observed to determine if the student has properly disassembled and assembled the injector. Also evaluate the accuracy of the cracking pressure. If necessary, have student review area of weakness. He should be encouraged to continue working with cracking pressure until all injectors in the set are the same pressure within the manufacturer's tolerance.
RESOURCES:	Engines, John Deere, pages 5-3l, 32 Engine Manufacturer's service manual

5.I.6 Removing, Replacing, and Timing Injection Pump

OBJECTIVE:	Given a diesel engine with injection pump, the student must remove, replace, and time the injection pump to manufacturer's specifications.
EQUIPMENT:	- diesel engine - manufacturer's service manual
STUDENT ACTION:	The student removes the injection pump. Care is given to proper cleaning and plugging of fuel lines (5.I.2). Once pump is removed the student replaces the pump and times it to the engine.
PERFORMANCE CHECK:	The student's performance is observed to determine if the student properly removed and replaced injection pump. Also determine if the pump is properly timed. The engine should start and run properly as a final indication of timing. If not discern the area of weakness and review the necessary material. The student should continue the task until he correctly times the pump.
RESOURCES:	U.A. Army Bulletin: Fuel Pumps; M.006-SL-SW-003, pages 66-67 Engine manufacturer's service manual.

5.1.7 Bleeding Fuel Systems

OBJECTIVE:	Given a diesel engine with a high pressure injection pump, the student must bleed the air from the system according to the manufacturer's specifications.
EQUIPMENT:	- an engine with high pressure fuel injection system
STUDENT ACTION:	The student bleeds the air from the fuel injection system. Sequencial progression is followed from filter(s) and/or sediment bowl to injection pump, then to the injectors.
PERFORMANCE CHECK:	The student's performance is observed to determine if the air has been eliminated from the system. A smooth running engine is the best indication. If necessary, determine the area of weakness and have the student perform the task again.
RESOURCES:	Toboldt, Diesel, page 290

5.1.8 Adjusting Detroit Unit-Injectors

OBJECTIVE:	Given a Detroit Diesel Engine, the student must adjust the injector timing, governor, and injector control rack according to the manufacturer's specifications.
EQUIPMENT:	- Detroit Diesel engine - timing gauge - service manual
STUDENT ACTION:	The student follows the specified procedure outlined in the service manual for tune-up of Detroit Diesel engines.
PERFORMANCE CHECK:	The student's performance is observed to determine the level of competency. Check the timing and rack adjustments for accuracy. If necessary, re-assign the task.
RESOURCES:	Detroit Diesel Engines Service Manual

5.2.0 Disassembling And Inspection

Removing accessories 5.2.1

Removing cylinder head 5.2.2

Removing valves and valve springs 5.2.3

Removing ridge from cylinder 5.2.4

Removing rods and pistons 5.2.5

Removing crankshaft 5.2.6

Removing camshaft 5.2.7

Inspecting bearings 5.2.8

5.2.1 Removing Accessories

OBJECTIVE:	Given a diesel engine to be disassembled, the student must remove the accessories (such as the air compressor, air conditioner compressor, generator) and label necessary wires and hoses for identification purposes.
EQUIPMENT:	- diesel engine with accessories
STUDENT ACTION:	The student removes the accessories from the engine. Care is given to marking hoses and wires for future identification during assembly.
PERFORMANCE CHECK:	The student's performance is observed to determine the level of competency. Check for identification of hoses and wires. Also check for proper handling and storage of accessories.
RESOURCES:	Manufacturer's service manual
NOTE:	If air condition lines are to be opened, use recommended procedure for discharging the system (not covered in this manual).

5.2.2 Removing Cylinder Head

OBJECTIVE:	Given a diesel engine, the student must remove the rocker arm assembly and the cylinder head.
EQUIPMENT:	- diesel engine (valve-in-head style)
STUDENT ACTION:	The student removes all parts attached to the cylinder head, such as water lines, manifolds, valve cover, injector linkage, rocker arms, and push rods. Head bolts are then removed. Visual inspection is made of each part as it is removed including the head gasket.
PERFORMANCE CHECK:	The student's performance is observed to determine the level of competency. Check for proper procedure which does not damage parts. Offer constructive suggestions as necessary. Also check for visual inspection of parts. Ask the student for an opinion of the condition of the engine from the visual inspection.
RESOURCES:	Engines, John Deere, pages 2-3 Engine manufacturer's service manual
CAUTION:	Do not pry on contact surfaces when removing manifolds and cylinder heads.

5.2.3 Removing Valves And Valves Springs

OBJECTIVE:	Given a diesel engine cylinder head, the student must disassemble the valve and spring assembles and inspect the assembly using care to keep all parts in order.
EQUIPMENT:	- valve spring compressor - diesel engine cylinder head (valve-in-head style)
STUDENT ACTION:	The student compresses the valve springs and removes the keepers, rotors, and springs. The valves are removed and kept in order.
PERFORMANCE CHECK:	The student's performance is observed to determine the level of competency. Check to see if the valves are kept in order. Ask the student for his evaluation from a visual inspection during disassembly.
CAUTION:	Make certain the valve spring compressor is securely placed on the spring and the compressor locked in position.

5.2.4 Removing Ridge From Cylinder

OBJECTIVE: Given a cylinder block and the necessary tools, the student must remove the ridge from the top of the cylinder.

EQUIPMENT:
- diesel engine in disassembly process
- ridge reamer

STUDENT ACTION: The student removes the ridge from the top of the cylinder in preparation of piston removal. Care is taken to thoroughly remove the ridge without cutting too deep.

PERFORMANCE CHECK: The student's performance is observed to determine the level of competency. Student evaluation is made on the proper use of the reamer and amount of metal removed. Offer constructive help where necessary.

RESOURCES: Engines, John Deere, pages 2-25

5.2.5 Removing Rods And Pistons From Cylinders

OBJECTIVE: Given a diesel engine, the student must remove the pistons and rods from the block without damage to the piston or rod.

EQUIPMENT:

- diesel engine in disassembly process
- soft mallet (possibly soft block of wood)
- metal dowel to insert in rod (optional)*

STUDENT ACTION: The student checks for identification marks on the rods and caps. If there are none then he marks each rod and cap according to the number of the cylinder. Check should be made for a mark which identifies the front of the pistons, in case the rods will be removed from the piston. The rods and pistons are then removed, the bearings inspected, and rod caps replaced on the rods.

PERFORMANCE CHECK: The student's performance is observed to determine the level of competency. Determine if any techniques are potentially harmful to the engine parts. If so, make constructive suggestions on technique. Check on the identification marks made by the student.

RESOURCES: Engines, John Deere, pages 2-26

* **NOTE:** A six to ten inch metal dowel may be screwed into the rod in place of the rod cap bolt and used to push out the rod and piston.

CAUTION: Each rod cap must be kept with the corresponding rod and not turned around on that rod.

5.2.6 Removing Crankshaft

OBJECTIVE:	Given a diesel engine in the disassembly process, the student must remove the crankshaft.
EQUIPMENT:	- diesel engine in disassembly process
STUDENT ACTION:	The student removes the necessary pulleys, covers, and gears for crankshaft removal. The student checks to insure that the main caps are marked for identification. If they are not marked, he should do so before disassembly. Main caps are removed and the bearings inspected. Make note of the position of oil holes in the bearings.
PERFORMANCE CHECK:	The student performance is observed to determine the level of competency. Check for identification markings on main caps.
CAUTION:	Make certain the caps are marked and can not be installed backward.

5.2.7 Removing Camshaft (And Balance Shaft)

OBJECTIVE: Given a diesel engine in the disassembly process the student must remove the timing gears, and camshaft (balance shaft if so equipped).

EQUIPMENT:
- a diesel engine in disassembly process
- gear pullers

STUDENT ACTION: Student uses manufacturer's recommendations to disassemble camshaft and timing mechanism. All timing gears are removed and inspected for wear (includes camshaft gear, crankshaft gear, injection pump drive, oil pump drive, balance shaft gear and idler gears). Camshaft (and balance shaft) are also removed. Cam bearings are inspected for wear.

PERFORMANCE CHECK: The student's performance is observed to determine the level of competency.

RESOURCES: Engines, John Deere, pages 2-62
Engine manufacturer's service manual.

5.2.8 Inspecting Bearings

OBJECTIVE:	Given a used bearing, the student must recognize the type of wear and make evaluation of the engine's condition.
EQUIPMENT:	- used bearings
STUDENT ACTION:	The student identifies the type of wear. He makes evaluation of the engine condition according to the wear and diagnoses possible causes of bearing failure.
PERFORMANCE CHECK:	The student is asked his evaluation of a variety of bearings. He should identify types of wear such as dirt, lack of oil, and fatigue.
RESOURCES:	Toboldt, Diesel, pages 270-272 Engines, John Deere, pages 2-58, 59, 60, 61

5.3.0 Re-Conditioning & Measuring

Cleaning & inspecting cylinder head 5.3.1

Checking valve spring tension 5.3.2

Replacing valve guides 5.3.3

Replacing valve seats 5.3.4

Resurfacing valve seats 5.3.5

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Checking piston pin bushings 5.3.10

Measuring crankshaft journals 5.3.11

Measuring camshaft and bearings 5.3.12

Reconditioning oil pump 5.3.13

5.3.1 Cleaning and Inspecting the Head

OBJECTIVE:	Given a diesel engine cylinder head, the student must clean and inspect the head to the instructor's satisfaction.
EQUIPMENT:	- diesel engine cylinder head - carbon scraper - bench grinder - electric drill and wire brush - straight edge
STUDENT ACTION:	The student cleans the head in preparation for rebuilding. He makes a visual inspection of the head for hair line cracks. Special care is given to the areas around and between the valves. The head is checked for warpage with a straight edge and thickness guage.
PERFORMANCE CHECK:	The student is asked for his evaluation of the condition of the head. Have him make recommendations on necessary rebuilding procedures.
RESOURCES:	Engines, John Deere, pages 2 - 4.

5.3.2 Checking Valve Spring Tension

OBJECTIVE: Given diesel engine valve springs, the student must check the springs for standing height and tension under compression and compare the readings to manufacturer's specifications.

EQUIPMENT:

- set of valve springs
- spring compression tester

STUDENT ACTION: The student checks the height and squareness of the valve spring and the tension of the spring when compressed to a specified height.

PERFORMANCE CHECK: The student's performance is observed to determine if the student correctly tests the spring.

RESOURCES: Engines, John Deere, pages 2 - 21.

5.3.3 Replacing Valve Guides

OBJECTIVE: Given a diesel engine cylinder head with replaceable valve guides, the student must determine if the old guides meet manufacturer's specifications and replace worn guides where necessary.

EQUIPMENT:

- diesel engine cylinder head
- inside micrometer
- new valve guides
- hydraulic press

STUDENT ACTION: The student measures the inside diameter of the valve guides to determine the amount of wear and necessity of replacement. Measurement should be in three places; top, bottom, and middle.

PERFORMANCE CHECK: The student's performance is observed to determine if the student correctly evaluates the need to replace or not replace valve guides.

RESOURCES:

Engines, John Deere, pages 2 - 14, 2 - 15
Diesel, Toboldt, pages 164, 120

5.3.4 Replacing Valve Seats

OBJECTIVE: Given a diesel engine cylinder head with replaceable valve seats, the student must replace the valve seats to meet the manufacturer's specifications.

EQUIPMENT:
- cylinder head
- valve seat installation tool

STUDENT ACTION: The student removes worn valve seats and replaces with new seats. The student learns to cut the head to prepare for the new seat. New seats are chilled to ease installation. If necessary, the head can be peened to hold the seat.

PERFORMANCE CHECK: The student's performance is observed to determine if the student correctly installed the new seat.

RESOURCES:
Engines, John Deere, pages 2 - 12
Diesel, Toboldt, pages 164, 262

5.3.5 Resurfacing Valve Seats

OBJECTIVE:	Given a diesel engine cylinder head, the student must resurface the valve seats to the manufacturer's specifications.
EQUIPMENT:	· diesel engine cylinder head · valve seat grinding machine
STUDENT ACTION:	The student grinds the valve seats using a valve seat grinder. Care is taken to obtain the correct seating angle and seat width. Seat should be ground to proper angle and narrowed to proper width.
PERFORMANCE CHECK:	The student's performance is observed to determine if the seats are resurfaced correctly. Check is made for width of seat, angle, and runout.
RESOURCES:	Engines, John Deere, pages 2 - 13, 2 - 14 Diesel, Toboldt, pages 262

5.3.6 Refacing Valves

OBJECTIVE:	Given a diesel engine cylinder head, the student must reface the valves according to the manufacturer's specifications.
EQUIPMENT:	- set of valves - valve grinder
STUDENT ACTION:	The student refaces the valves and determines if new valves are needed. Special attention is given to the grinding techniques and angle of face. Student must make evaluation of the usability after the valve is ground.
PERFORMANCE CHECK:	The student's performance is observed to determine if the student ground valves at the correct angle, and used the correct technique. The student's evaluation of the valve's condition is assessed by the instructor.
RESOURCES:	Engines, John Deere, pages 2 - 10, 11, 12 Diesel, Toboldt, pages 262

5.3.7 Measuring Taper of Cylinders

OBJECTIVE:	Given a diesel engine in the overhaul process, the student must measure the taper in the cylinder and make evaluation of the condition of the engine and determine what is necessary for rebuilding the engine.
EQUIPMENT:	- a diesel engine in the overhaul process - inside micrometer (or taper gauge)
STUDENT ACTION:	The student determines the amount of taper in the cylinder by the use of an inside micrometer or taper gauge. After taking the measurements, the student determines whether the engine can be rebuilt by honing or whether boring is required.
PERFORMANCE CHECK:	The instructor determines if the student has properly measured the taper of the cylinder. The instructor must observe the student's accuracy. The student must be able to determine whether the cylinder needs honing or boring or replaced.
RESOURCES:	Engines, John Deere, pages 2 - 26 Diesel, Toboldt, page 264

5.3.8 Deglazing Cylinder

OBJECTIVE: Given an engine block for major overhaul, the student must hone the cylinder block to remove the glaze according to the manufacturer's specifications.

EQUIPMENT:

- diesel engine
- cylinder hone
- diesel fuel or light weight oil
- electric drill

STUDENT ACTION: The student removes the glaze from the cylinder with a cylinder hone. Emphasis is given to the proper speed and rapidity of stroke with the hone. Proper cross hatching should be obtained in the cylinder wall. Manufacturer's specifications on use of lubricant should be followed. Care must be taken not to remove more material than necessary from the cylinder surface.

PERFORMANCE CHECK: The instructor observes the student's honing procedure. Emphasis is given to proper cross hatch and the amount of material removed. Evaluation should be made on whether or not the student has effectively removed the the scratches and restored the cylinder to rebuildable condition. Also evaluation should be made on whether the student has honed away too much of the material.

RESOURCES:

Engines, John Deere, pages 2-27, 28
Diesel, Toboldt, page 267

NOTE: Depending on the evaluation made in 5.3.7, this task may be replaced by 5.4.2.

5.3.9 Cleaning and Inspecting Pistons

OBJECTIVE:

Given a set of pistons, the student must clean and inspect the pistons and make judgment concerning continued use according to the manufacturer's specifications.

EQUIPMENT:

- ring groove cleaner
- chemical solution for soaking (highly recommended)
- feeler gauge
- manufacturer's specifications

STUDENT ACTION:

The student cleans the pistons using care not to scratch or damage the piston. After cleaning, the piston is inspected for cracks and extent of wear. Skirt diameter must be measured and the clearance between skirt and the reconditioned cylinder wall checked. The student measures the wear on the piston skirt with a micrometer. The ring grooves are measured for wear with new rings and feeler gauge. Visual inspection is made for cracks. Student compares his findings with the manufacturer's specifications and makes evaluation of the need for replacement.

PERFORMANCE CHECK:

The instructor checks the measurements and assesses the student's evaluation. Determine if the student drew the proper conclusion on the basis of the data accumulated.

RESOURCES:

Engines, John Deere, pages 2 - 41, 42
Diesel, Toboldt, pages 275, 276

5.3.10 Checking Piston Pin Bushing

OBJECTIVE:	Given the rod and piston, the student must check the fit of the piston, piston pin, rod, and bushing and compare to manufacturer's specifications.
EQUIPMENT:	- set of pistons and rods
STUDENT ACTION:	The student makes inspection of the piston pin bushings and rod. Proper floating action is observed and emphasis is given to excessive wear. Wear is checked against manfacturer's specifications. Student makes his recommendation of necessary repairs.
PERFORMANCE CHECK:	The instructor checks the piston pin, bushing, and rod, and compares the student's evaluation of necessary repair with the data. Have the student explain his recommendation if necessary for clarification. If there is error in student's evaluation, assign remediation to develop accuracy of the evaluation.
RESOURCES:	*Engines*, John Deere, pages 2 - 44, 45, 46 *Diesel*, Toboldt, pages 272, 273

5.3.II Measuring Crankshaft

OBJECTIVE: Given a micrometer and crankshaft, the student must measure the crankshaft to determine the wear and the roundness of the shaft and evaluate the condition of the crankshaft.

EQUIPMENT:

- micrometer
- crankshaft

STUDENT ACTION: The student measures the crankshaft for wear, taper, and roundness, and compares the readings to the manufacturer's specifications. Using the comparison, the student makes evaluation of the crankshaft condition.

PERFORMANCE CHECK: The instructor determines if the student has correctly measured the crankshaft by observing the technique, and by checking the measurements. Determine if the evaluation made by the student is correctly supported by the evidence.

RESOURCES: Engines, John Deere, pages 2 - 46, 2 - 53
Diesel, Toboldt, pages 170-172, 247-250

5.3.12 Measuring Camshaft and Bearings

OBJECTIVE: Given a diesel engine in the disassembly process, the student must measure the camshaft and camshaft bearings for wear and compare to the manufacturer's specifications

EQUIPMENT:
- a diesel engine in the overhaul process
- inside and outside micrometer

STUDENT ACTION: The student measures each camshaft (and balance shaft) bearing. He compares the measurement to the manufacturer's specifications and makes evaluations concerning the replacement of bearings. Also, he measures the camshaft for wear. The cam followers are inspected for wear. The instructor measures the camshaft and bearings too.

PERFORMANCE CHECK: Determine if the student properly measured the camshaft and camshaft bearings. The accuracy of the measurement should be within 0.001. The instructor assesses the student's evaluation of whether to replace the camshaft (and balance shaft) and/or bearings.

RESOURCES: Engines, John Deere, pages 2-18, 2-19, 2-20
Diesel, Toboldt, page 269

5.3.13 Reconditioning Oil Pump

OBJECTIVE:	Given an oil pump, the student must rebuild the pump to the manufacturer's specifications.
EQUIPMENT:	- a diesel engine in the overhaul process
STUDENT ACTION:	The student removes, disassembles, evaluates the condition and rebuilds or replaces the oil pump.
PERFORMAHCE CHECK:	The instructor determines if the student has properly rebuild the oil pump to meet the manufacturer's specifications.
RESOURCES:	Engines, John Deere, pages 7 - 2, 7 - 3 Diesel, Toboldt, page 216

5.4.0 Assembling

Installing new gaskets 5.4.1

Installing sleeves 5.4.2

Installing camshaft 5.4.3

Installing crankshaft 5.4.4

Installing timing gears 5.4.5

Installing rings 5.4.6

Installing pistons 5.4.7

Installing rod bearings 5.4.8

Installing oil pump 5.4.9

Installing cylinder head 5.4.10

Installing rocker arm assembly 5.4.11

Installing pan, valve covers 5.4.12

Installing accessories 5.4.13

5.4.1 Installing New Gaskets

OBJECTIVE:	Given new gaskets and gasket compound, the student must install new gaskets so there are no leaks.
EQUIPMENT:	- gaskets - gasket compound - diesel engine in rebuilding process
STUDENT ACTION:	The student installs all gaskets at the specified time in rebuilding process. Care is given to proper placement, alignment, and tightening. A careful check is made for proper hole patterns.*
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student meets the specifications. The assembled engine must be observed for leaks as a final performance check.
* CAUTION:	Close observation should be made to insure that no holes or passages are plugged by gaskets. Head gaskets are of prime concern for the flow of water and oil.

5.4.2 Installing Sleeves

OBJECTIVE:	Given a diesel engine in the rebuilding process, the student must remove and replace cylinder liners (wet or dry) to meet the manufacturer's specifications.
EQUIPMENT:	- diesel engine - new set of sleeves - sleeve puller set
STUDENT ACTION:	The student removes the sleeves using care not to damage the block. On wet sleeves, the water jacket is cleaned. Care is given to cleaning the seating area. New sleeves are installed using care not to damage the "O" ring seal. On dry sleeves, care is given to a clean block and tight seal.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly prepares and installs the sleeves.
RESOURCES:	Engines, John Deere, pages 2-25,26 Toboldt, Diesel, pages 152, 153

5.4.3 Installing Camshaft (And Balance Shaft)

OBJECTIVE:	Given a diesel engine in the rebuilding process, the student must install the camshaft and new bearings where necessary, according to the manufacturer's specifications.
EQUIPMENT:	- diesel engine in rebuilding process - camshaft bearing installation tool
STUDENT ACTION:	The student installs the new camshaft bearings according to the manufacturer's recommendation. Care is given to proper alignment and installation technique. The camshaft is installed and checked for proper oil clearance. Camshaft followers are also installed at the proper time.
PERFORMANCE CHECK:	The instructor observes the student's procedure to determine if the student properly installs the camshaft bearings. The camshaft installation is also observed.
RESOURCES:	*Engines,* John Deere, pages 2-20 Toboldt, *Diesel,* pages 166-170,268 See 5.3.12

5.4.4 Installing Crankshaft, Main Bearings, And Oil Seals

OBJECTIVE:	Given an engine in the rebuilding process, the student must install the crankshaft, main bearings and oil seals according to manufacturer's specifications.
EQUIPMENT:	- diesel engine in rebuilding process - set of main bearings - torque wrench - oil seals
STUDENT ACTION:	The student installs dry bearings (also oil seal) and crankshaft in the block. Two or three main caps are installed with plastigage and torqued to specifications. Caps are removed and measurement checked. If the oil clearance meets the specifications of the manufacturer, then the crankshaft is removed, and the bearings oiled, installed, and torqued to specifications.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student correctly measures and installs the crankshaft and bearings.
NOTE:	The crankshaft must not be turned when plastigage is in place.

5.4.5 Installing Timing Of Gears

OBJECTIVE: Given diesel engine in the rebuilding process, the student must install the timing gears to the manufacturer's specifications.

EQUIPMENT:

- diesel engine in the rebuilding process

STUDENT ACTION: The student uses manufacturer's specifications to assemble the timing gears (includes camshaft, crankshaft, injection pump drive, oil pump drive, balance shaft, idler gears, etc.)

PERFORMANCE CHECK: The instructor observes the student's work to determine if gears are installed properly.

RESOURCES: Engines, John Deere, pages 2-17, 2-62.
Toboldt, Diesel, pages 269, 270

5.4.6 Installing Rings On Pistons

OBJECTIVE:	Given clean (or new) pistons and new rings, the student must install the new rings on the pistons according to the manufacturer's specifications.
EQUIPMENT:	- set of pistons - new ring set - ring expander
STUDENT ACTION:	The student uses the ring manufacturer's specifications for installing the rings. The student should guard against scratching the piston as the rings are installed.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if he installs the rings properly. Determine if the rings are positioned according to manufacturer's specifications before piston installation.
RESOURCES:	Engines, John Deere, pages 2-39, 40, 41, 42 Toboldt, Diesel, pages 275, 276

5.4.7 Installing Pistons

OBJECTIVE:	Given a diesel engine in the rebuilding process, the student must install the pistons and rings (see 5.4.6) by compressing the rings and inserting the piston into the cylinder.
EQUIPMENT:	- set of pistons with rings installed - ring compressor
STUDENT ACTION:	The student oils the rings and pistons, compresses the rings, and installs the pistons in the cylinders. Care is given to not force pistons if undue resistance is incurred.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student properly installs the pistons.
RESOURCES:	Engines, John Deere, pages 2-43, 44 Toboldt, Diesel, page 276
NOTE:	Make certain that the crankshaft throw is on the bottom where the piston and rod are installed.

5.4.8 Installing Rod Bearings

OBJECTIVE:	Given plastigage, the student must install the rod cap and measure the oil clearance of the rod bearings.
EQUIPMENT:	- diesel engine in rebuilding process - package of plastigage - set of rod bearings to be checked - torque wrench
STUDENT ACTION:	The student installs dry rod bearings with plastigage and torques to specifications. Bearing cap is removed and plastigage measured. If oil clearance is within manufacturer's specifications, the bearings are lubricated, caps replaced, and torqued to proper specifications.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine the level of competency. Make positive suggestions for corrections as necessary.
RESOURCES:	Engines, John, Deere, pages 2-47, 48 Toboldt, Diesel, page 273

5.4.9 Installing Oil Pump

OBJECTIVE: Given an engine in the rebuilding process, the student must install the oil pump according to the manufacturer's specifications.

EQUIPMENT:

- oil pump

STUDENT ACTION: The student installs the oil pump.

PERFORMANCE CHECK: The instructor observes the student's performance to determine if the student correctly installed the pump.

CAUTION: Make certain oil pressure relief valves are functioning and installed correctly.

5.4.10 Installing Cylinder Head

OBJECTIVE:	Given a head gasket and torque wrench; the student must install the gasket and tighten the head bolts to the proper torque specifications in the proper sequence as prescribed. by the manufacturer's specifications.
EQUIPMENT:	- head gasket - torque wrench - diesel engine in rebuilding process
STUDENT ACTION:	The student installs the head gasket and head. The head must be tightened according to the manufacturer's specifications. Manufacturer's recommendations for head gasket installation are followed.
PERFORMANCE CHECK:	The instructor observes the student action to determine if the head gasket and head are installed correctly. Special attention is given to the proper sequence in tightening the head bolts.
RESOURCES:	Engines, John Deere, pages 2-4, 5 Toboldt, Diesel, page 264
CAUTION:	Some engines have oil passages in head bolts. Make certain they are installed in the correct place.

5.4.11 Installing Rocker Arm Assembly

OBJECTIVE:	Given the rocker arm assembly, the student must install the component parts and adjust the valves to the manufacturer's specifications.
EQUIPMENT:	- rocker arm assembly
STUDENT ACTION:	The student installs the push rods and rocker arm assembly and tightens to the manufacturer's specifications. The student must adjust the valve lash. The student draws from knowledge of firing order, valve timing and valve lash. The crankshaft must be rotated to the proper position for each valve adjustment.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student meets the specifications. Particular attention must be given to the installation of the push rods and the position of the crankshaft during valve lash adjustment.
RESOURCES:	Engines, John Deere, pages 2-22 See 2.8.4

5.4.12 Installing Pan, Manifolds, Valve Covers

OBJECTIVE:	Given a diesel engine in the rebuilding process, the student must install the oil pan, manifolds, valve cover(s) and other similar items to the manufacturer's specifications.
EQUIPMENT:	- necessary parts
STUDENT ACTION:	The student installs the pan, valve covers, manifolds and other similar items and tightens them to the manufacturer's torque specifications.
PERFORMANCE CHECK:	The instructor observes the student's performance to determine if the student meets the specifications.

5.4.13 Installing Accessories

OBJECTIVE: Given a diesel engine in the rebuilding process, the student must install the accessories to complete the reassembly process.

EQUIPMENT:

- remaining parts and accessories

STUDENT ACTION: The student completes the assembly process by installing the remaining covers and attachments (water pump, pulleys, flywheel, generator, air compressor, etc.) to the manufacturer's specifications.

PERFORMANCE CHECK: The instructor determines by observation if the student has properly installed the accessories.

Bibliography

Diesel and High Compression Gas Engines, Edgar J. Kates, American Technical Society, Chicago, Illinois

Diesel Engine Manual, Perry O. Black, Theodore Audel and Company, 4300 West 62nd Street, Indianapolis, Indiana 46268

Diesel-Fundamentals, Service, Repair, William K. Toboldt, The Goodheart-Willcox Company, Inc., South Holland, Illinois

Engines-Fundamentals of Service, Deere and Company, Department F, John Deere Road, Moline, Illinois 61265

CONSTRUCTION SURVEYING

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6.1.0 Measurements

Measuring A Distance 6.1.1

Layout Of A Given Distance 6.1.2

6.1.1 Measuring A Distance

OBJECTIVE: Using a 100 foot steel tape, the student measures the distance between two points to 1.0% accuracy.

EQUIPMENT: One set for each group of 3 or 4 students.

- 100 -ft. steel tape
- set of eleven surveyor's pins
- set of notes and pencils

STUDENT ACTION: The student determines the distance between the two stakes and records the reading in a systematic form. The student measures distance of less than 100 -ft. initially. He then learns to use surveyor's pins and measure distance greater than 100 -ft.

PERFORMANCE CHECK: Determine if student's measurements are within 1.0% tolerance of prepared distance. If not, discuss the factors that introduce error into measurements. Have the student remeasure the distance between the stakes and attempt to obtain 1.0% accuracy.

RESOURCES: Brinker, Russell C., Elementary Surveying, Fifth Edition, International Textbook Company, Scranton, Pennsylvania, pages 50-56, 69-72, 75-76

Farm Surveying, VAS3010, University of Illinois, College of Agriculture, Urbana, Illinois

6.1.2 Layout of A Given Distance

OBJECTIVE:	Using a 100 -ft. steel tape, the student lays out a given distance to 1.0% accuracy.
EQUIPMENT:	One set for each group of 3 or 4 students. - 100-ft. steel tape - set of eleven surveyor's pins - set of notes and pencils
STUDENT ACTION:	The student lays out the given distance, using care to keep a straight line and 1.0% accuracy. The student is given one point and a direction to measure.
PERFORMANCE CHECK:	Determine if the layout is within 1.0% accuracy of the given distance. If not, discuss factors that introduce error into measurements. Have the student measure another given distance in an attempt to obtain 1.0% accuracy.
RESOURCES:	Brinker, Russell C., Elementary Surveying, Fifth Edition, International Textbook Company, Scranton, Pennsylvania, pages 50-56, 69-72, 75-76.

6.2.0 Elevations

Setting up of instrument 6.2.1

Reading of target rod 6.2.2

Recording of field notes 6.2.3

Elevation, determine with hand level 6.2.4

Elevation, determine with dumpy level 6.2.5

6.2.1 Setting Up Of Instrument

OBJECTIVE: Using a tripod and level, the student must set up the instrument and level to within less than one graduation on the level tube.

EQUIPMENT: One for each group of 3 or 4 students.

- tripod
- dumpy level (or similar instrument)

STUDENT ACTION: The student sets up the instrument and levels it to the specification. The tripod is securely stationed in the ground so it can not easily be bumped and introduce error in the readings

PERFORMANCE CHECK: Observe the student to determine if he has leveled the instrument to the specification. Also check the tension on the leveling screws. If the performance does not meet the specifications, have him practice turning leveling screws in opposite direction while maintaining tension and level to specifications with an instructor observing.

RESOURCES: Brinker, Russel C., Elementary Surveying, Fifth Edition International Tesbtook Company, Scranton, Pennsylvania, pages, 101-109.

6.2.2 Reading Of Target Rod

OBJECTIVE:	Given any point on a target rod, the student must read that point to the nearest 0.01 foot.
EQUIPMENT:	- 7- ft. by 13- ft. Philadelphia rod (or the equivalent).
STUDENT ACTION:	The student reads the given points on the target rod.
PERFORMANCE CHECK:	Observe the student to determine if he is reading the target rod.
NOTE:	The use of dollars, dimes and pennies has proven helpful in aiding the understanding of the graduation on the target rod.

6.2.3 Recording Of Field Notes

OBJECTIVE:	Using the format of Appendix 6.2.3a, the student records and computes field notes to the instructor's satisfaction.
EQUIPMENT:	Appendix - 6.2.3a
STUDENT ACTION:	The student records his reading in the proper format and makes the mathematical computations. The student learns the definition of "height of instrument," "turning point", and "bench mark". The student learns to compute the difference in elevation between points.
PERFORMANCE CHECK:	Assign a problem and check for correctness. If there is error, determine if it is in procedure, or mathematical computation. When necessary, review the procedure.
RESOURCES:	Brinker ..... pages 137, 520-527.

6.2.4 Elevation, Determine With Hand Level

OBJECTIVE:	Using a hand level and target rod, the student determines the difference in elevation between two points to ± 0.1 ft.
EQUIPMENT:	- hand level - Philadelphia rod (or its equivalent) - set of notes and pencils
STUDENT ACTION:	Layout sets of two stakes and determine the difference in elevation of the stakes.
PERFORMANCE CHECK:	Determine if the student's reading is within the specifications
RESOURCES:	Brinker .... pages 112, 114.

6.2.5 Elevation, Determine With Dumpy Level

OBJECTIVE:	Given a tripod, level, and target rod, the student finds the difference in elevation between two given points to within ± 0.05 -ft.
EQUIPMENT:	One set for each group of 3 or 4 students. - tripod - dumpy level (or similar instrument) - Philadelphia rod (or its equivalent)
STUDENT ACTION:	The student determines the difference in elevation between two given points.
PERFORMANCE CHECK:	Determine if the student's performance is within the specifications. If there is error, discuss ways in which error is possibly introduced. Supplementary tasks (6.2.1, 6.2.2) should be reviewed where necessary. The task should then be repeated for remediation.
RESOURCES:	Brinker .... pages 121-127 Barry .... pages 12, 13, 28 -30.

6.3.0 Layouts

Setting of grade stakes 6.3.1

Laying out 4-sided building 6.3.2

Computing slope between two points 6.3.3

Laying out of trench 6.3.4

6.3.I Setting Of Grade Stakes

OBJECTIVE:	Given the needed specifications of elevation and location, the student sets grade stakes to within ± 0.05 -ft. of specifications for elevation and 0.25 % accuracy on linear specifications.
EQUIPMENT:	- I00 -ft steel tape - set of surveyor's pins - tripod - dumpy level (or similar instrument) - Philadelphia rod (or its equivalent) - I x 2 -in. or 2 x 2 -in. grade stakes
STUDENT ACTION:	The student uses the skills learned in tasks - 6.I.2, 6.2.I, 6.2.2. He combines the three tasks into the job of setting grade stakes.
PERFORMANCE CHECK:	Determine if the student's performance is within the specifications. Spot check the elevations and measurements to determine the accuracy of the student performance. If there is error discuss where error could have been introduced into the measurements. Repeat any supplementary tasks (6.I.2, 6.2.I, 6.2.2) that might help the weakness. Repeat task 6.3.I.
RESOURCES:	Barry .... chapter 9 Brinker .... chapter 2I

6.3.2 Laying Out Of 4-Sided Building

OBJECTIVE: Given the dimensions and materials, the student lays out a four-sided building to ± 0.05 -ft. of specification of elevation and 0.25% accuracy on linear specifications.

EQUIPMENT:

- 100 -ft. steel tape
- set of surveyor's pins
- tripod
- dumpy level (or similar instrument)
- 2 x 2 -in. or 2 x 4 -in. grade stakes
- 1 x 4 -in. x 6 -ft. batter boards

STUDENT ACTION: The student uses the skills of tasks 6.1.2, 6.2.1 and 6.2.2. He combines these tasks into the job and lays out the corner stakes and batter boards for a four-sided building.

PERFORMANCE CHECK: Determine if the student's performance is within the specifications. Spot check the elevations and measurements to determine the accuracy of the student performance. If there is error discuss where error could have been introduced into the measurements. Repeat any supplementary tasks (6.1.2, 6.2.1, 6.2.2) that might help the weakness. Repeat task 6.3.2.

RESOURCES: Barry .... chapter 10.

6.3.3 Computing The Slope Between Two Points

OBJECTIVE: Given the difference in elevation of two points and the distance between the two points, the student computes the slope (or fall) to ± 0.25% accuracy.

STUDENT ACTION: The student computes the slope between two points.

PERFORMANCE CHECK: Determine if student's calculations are correct and within the specifications. If not, determine if error is in concept or mathematical calculation. Review concept, if necessary. Give remedial tasks of 6.3.3.

RESOURCES: Brinker .... pages 74, 75.

6.3.4 Laying Out Of Trench

OBJECTIVE: Given all the layout specifications, the student must stake out a trench to ± 0.05 -ft. of specifications of elevation and 0.25% accuracy on linear measurement.

EQUIPMENT:

- 100 -ft. steel tape
- set of surveyor's pins
- tripod
- dumpy level (or similar instrument)
- Philadelphia rod (or its equivalent)
- grade stakes (1 x 2 -in. or 2 x 2 -in.)

STUDENT ACTION: The student recalls the skills of task 6.1.2, 6.2.1, 6.2.2 and 6.3.3. He combines the skills of these tasks to perform the job of laying out a trench with proper fall and offset stakes.

PERFORMANCE CHECK: Determine if the student's performance is within the specifications. Spot check the stakes for accuracy. If there is error, discuss where the error could be introduced. Review the supplementary tasks (6.1.2, 6.2.1, 6.2.2, 6.3.2) where the student shows weakness. Repeat task 6.3.4.

RESOURCES: Barry .... chapter 11.

Bibliography

Construction Measurements, B. Austin Barry, John Wiley and Sons, New York.

Elementary Surveying, fifth edition, Russell C. Brinker, International Textbook Company, Scranton, Pennsylvania.

Farm Surveying, VAS 3010, University of Illinois, College of Agriculture, Urbana, Illinois.

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